Study The Relationship Between Arterial Blood Pressure and Child Length During Period 6 -14 Years Old

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Abstract

Background: Vital signs are an objective assessment of the crucial physiological activities of a living organism.

Aim: To assess the relationship between height components and both systolic and diastolic blood pressure in children aged 6 to 14 years.

Patients and methods: This cross-sectional study was conducted at the Department of Pediatrics, Al-Azhar University Hospital – Assuit. A total of 200 children, both sexes, aged between 6 and 14 years who presented to the Outpatient Pediatrics Clinics were eligible for recruitment.

Results: A total of 200 children aged between 6 and 14 years were included in the study. Body length ranged from 102–165 cm (mean ± SD: 132.2 ± 14.16), sitting length — measured as the vertical distance from the top of the head (vertex) to the seated surface while sitting upright — ranged from 45–84 cm (64.2 ± 9.41), and leg length 23–104 cm (68 ± 11.97). Systolic blood pressure ranged from 65–120 mmHg (94.1 ± 15.76), diastolic BP 40–80 mmHg (61.5 ± 10.26), and mean arterial pressure (MAP) 48–93 mmHg (72.3 ± 10.29). Total length showed significant positive correlations with systolic ($r = 0.265$, $P < 0.001$) and diastolic BP ($r = 0.416$, $P < 0.001$). Sitting length also correlated significantly with systolic ($r = 0.243$, $P < 0.001$) and diastolic BP ($r = 0.298$, $P < 0.001$). Leg length showed a non-significant correlation with systolic BP ($r = 0.122$, $P = 0.084$) but a significant correlation with diastolic BP ($r = 0.258$, $P = 0.002$).

Conclusion: In children aged 6–14 years, height and sitting length showed positive correlations with both systolic and diastolic blood pressure. Leg length correlated positively only with diastolic blood pressure, with no significant link to systolic pressure.

Key words: Anthropometry; Systolic blood pressure; Diastolic blood pressure; Pediatric population

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Introduction

Vital signs are an objective assessment of the crucial physiological activities of a living organism. They have the name "vital" as their assessment and measurement is the crucial 1st step for any clinical estimation. The 1st set of clinical investigations is an estimation of the vital signs of the case. Triage of cases in an emergency department or an urgent/prompt care is determined by their vital signs, which indicate the physician the level of derangement that is occurring from the baseline [1].

The correlations among height, leg (lower body) and trunk (upper body) length, with BP in kids has rarely been examined. It is crucial to evaluate the importance of every element independent of the other is possible given their moderate association [2,3]. Rapid rises in weight and height in the 1st few months of life have been corelated with elevated systolic blood pressure in early childhood, adulthood and adolescence [3].

A comparatively longer trunk length may be correlated with elevated blood pressure if the distance from the heart to the vertex of the head decides the arterial blood pressure that ensures sufficient brain perfusion. In adults, the evidence argues versus that hypothesis since most investigations have illustrated a weak or null inverse correlation of trunk length with blood pressure.6,8–13 Alternatively, longer legs might be correlated with elevated BP [2,4].

It was stated that BP is closely correlated with height and bodyweight in kids. Pubertal growth result in a significant rise of height, in addition to a significant rise in pressure. In other words, the pressure of kids is strongly affected by their pubertal status. Consequently, pressure investigation not only at the beginning of puberty but also at the end of puberty is useful programs of health education [5,6].

Regnault et al[7] concluded that kids with greater upper segment length had higher blood pressure, maybe due to the need to overcome gravity to perfuse the brain. Following taking trunk length into account, we observed no evidence for a correlation of leg length and blood pressure [7].

Ethical consideration:

1. The research was approved by the Ethical Committee of the Faculty of Medicine, Al-Azhar University.
2. Informed oral consent was obtained from all participants after proper counseling.
3. Informed consent was also obtained from the parents of the participating children.
4. Participants were given the option to decline participation in the study if they wished.
5. Adequate measures were taken to maintain the privacy and confidentiality of all data.
6. Each participant was assigned a code number, with names and addresses kept in a secure, separate file.
7. Patient names were anonymized in all research outputs.
8. Study results were used solely for scientific purposes and not for any other aims.

Inclusion criteria:

- Children aged between 6 and 14 years presenting to the Outpatient Pediatrics Clinics were eligible for inclusion in the study.
- Both male and female children were included.

Exclusion criteria:

- Age below 6 years or above 14 years
- Known to be hypertensive on treatment
- Children with renal disease
- Children with cardiac disease

Study methods:
This cross-sectional study was conducted at the Department of Pediatrics, Al-Azhar University Hospital – Assuit. A total of 200 children aged between 6 and 14 years were expected to participate in the study.

All children were subjected to the following:
I-**Detailed history** including age, sex, and residence. Blood pressure and anthropometric measurements were obtained using standardized protocols [8]. Height was measured using a calibrated wall-mounted stadiometer while the child stood barefoot, with heels together, back straight, and head positioned in the Frankfort horizontal plane. Sitting height — representing trunk length — was assessed by having the child sit upright on a firm, flat surface with the back straight against a vertical board or wall. The head was maintained in the Frankfort plane, knees facing forward, and feet hanging freely. The stadiometer was placed firmly on the vertex of the head for measurement. Leg length was then calculated as the difference between standing height and sitting height. All anthropometric assessments were performed by trained personnel who underwent biannual in-service training to ensure measurement accuracy and inter-rater reliability. Measurements were taken twice for each child and the average was recorded to enhance precision.

II-Blood pressure measurement [9]: Using biannually calibrated Dinamap Pro-100 oscillometric automated monitors. Trained research assistants recorded BP readings from the child's upper arm, with up to five measurements taken at 1-minute intervals. While oscillometric devices are practical for pediatric assessments, they may overestimate systolic (SBP) and diastolic blood pressure (DBP) compared to auscultatory methods, potentially leading to misclassification of BP status.
Measurement conditions were carefully documented, including the order of readings, cuff size, limb used, body position, and the child's behavioral state during the measurement. At the early childhood visit, behavioral states included: sleeping, quietly awake, actively awake, or crying. At the mid-childhood visit, states included: still, moving, quiet, or talking. Pulse pressure (PP) was calculated as the difference between systolic and diastolic readings (PP = SBP – DBP).

Statistical analysis:
Data was statistically be defined in terms of range, mean □ standard deviation (□ SD), median, frequencies (number of patients) and percentages when appropriate. For comparison categorical information, Chi square (□2) test is carried out. Exact test has been utilized instead when the expected frequency is below 5. p values below 0.05 has been deemed statistically significant. All statistical measurements have been done utilizing computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, United States of America) version 26 for Microsoft Windows.

Results
All results will be presented in the following tables

A mean value (± SD) of age was 10.1 (±2.14) years. There were 84 (42%) male and 116 (58%) female. Weight was with a mean value (± SD) of 48.1 (±14.79) kg. A mean value (± SD) of BMI was 28.9 (± 12.67) kg/m2. There were 104 (52%) patients from rural areas and 96 (48%) patients from urban areas.

Table 1: General characteristic of the examined cases

		(n=200)
Age (years)	**Mean ± Stander Deviation**	10.1 ± 2.14
Gender	**Male**	84 (42%)
	Female	116 (58%)
Weight (kilogram)	**Mean ± Stander Deviation**	48.1 ± 14.79
BMI (kilograms per square meter)	**Mean ± Stander Deviation**	28.9 ± 12.67
Residence	**Rural**	104 (52%)
	Urban	96 (48%)

Table (1) Illustrates the demographic data of the examined cases.

Table 2: Length, length score of the studied patients

		(n=200)
Length (centimeter)	Mean ± SD	132.2 ± 14.16
	Range	102 - 165
Sitting length (centimeter)	Mean ± SD	64.2 ± 9.41
	Range	45 - 84
Leg Length (centimeter)	Mean ± SD	68 ± 11.97
	Range	23 - 104

Table 2 shows that length varied from 102 to 165 centimeter with a mean value (± Stander Deviation) of 132.2 (±14.16) centimeter. Sitting length varied from 45 to 84 centimeter with a mean value (± Stander Deviation) of 64.2 (±9.41) centimeter. Leg length varied from 23 to 104 centimeter with a mean value (± Stander Deviation) of 68 (±11.97) centimeter.

Table 3: Length score of the studied patients

		(n=200)
Length score	Median (IQR)	-0.16 (-0.79 – 0.83)
Sitting length score	Median (IQR)	-0.02 (-0.77 – 0.63)
Leg Length score	Median (IQR)	-0.17 (-0.67 – 0.58)

Table 3 shows that length score was with median (IQR) -0.16 (-0.79 – 0.83). Sitting length was with median (IQR) -0.02 (-0.77 – 0.63). Leg length was with median (IQR) -0.17 (-0.67 – 0.58).

Table 4: Systolic, diastolic and mean arterial blood pressure of the studied patients

		(n=200)
Systolic blood pressure (millimeters of mercury)	Mean ± SD	94.1 ± 15.76
	Range	65 - 120
Diastolic blood pressure (millimeters of mercury)	Mean ± SD	61.5 ± 10.26
	Range	40 - 80
Mean arterial blood pressure (millimeters of mercury)	Mean ± SD	72.3 ± 10.29
	Range	48 - 93

Table 4 shows that Systolic blood pressure ranged from 65 to 120 mmHg with a mean value (± SD) of 94.1 (±15.76) mmHg. Diastolic blood pressure ranged from 40 to 80 mmHg with a mean value (± SD) of 61.5 (±10.26) mmHg. Mean arterial blood pressure ranged from 48 to 93 mmHg with a mean value (± SD) of 72.3 (±10.29) mmHg.

Table 5: Correlation between sex (male and female) and (length, SBP and DBP) of the studied cases

		Male	Female
Length (cm)	r	-0.021	0.021
	P-value	0.757	0.757
SBP (millimeters of mercury)	r	-0.084	0.084
	P-value	0.259	0.259
DBP (millimeters of mercury)	r	-0.07	0.07
	P-value	0.302	0.302

Table 5 shows that there was no correlation between sex (male and female) and (length, systolic and diastolic blood pressure).

Table 6: Correlation among BMI and (length, systolic and diastolic blood pressure) of the studied patients

		BMI
Length (cm)	r	-0.639
	P-value	**<0.001***
SBP (millimeters of mercury)	r	-0.210
	P-value	**0.003***
DBP (millimeters of mercury)	r	-0.246
	P-value	**<0.001***

Table 6 shows that there was negative correlation between BMI and (length, SBP and DBP) (P-value below 0.05).

Table 7: Association among length and (SBP and DBP) of the studied patients

		Length
SBP	r	0.265
	P-value	**<0.001***
DBP	r	0.416
	P-value	**<0.001***

*Significant as P value not more than 0.05

Table 7 Illustrates a positive association has been observed between length and (SBP and DBP) (P value below 0.001).

Table 8: Association between sitting length and (SBP and DBP) of the studied patients

		Sitting length
SBP (millimeters of mercury)	r	0.243

	P-value	**<0.001***
DBP (millimeters of mercury)	**r**	0.298
	P-value	**<0.001***

Table 8 Illustrates that there was positive association between sitting length and (SBP and DBP) (P value below 0.001).

Table 9: Correlation between leg length and (systolic and diastolic blood pressure) of the studied patients

		Leg length
Systolic blood pressure (mmHg)	**r**	0.122
	P value	0.084
Diastolic blood pressure (mmHg)	**r**	0.258
	P value	**0.002***

Table 9 Illustrates that; there was no correlation between leg length and systolic blood pressure. There was a positive correlation between leg length and diastolic blood pressure (r=0.258 and P value =0.002).

Discussion

In the current research, age with a mean value (± SD) of 10.1 (±2.14) years. There were 84 (42%) male and 116 (58%) female. Weight with a mean value (± SD) of 48.1 (±14.79) kg.

Supporting, **Tebar et al.**[10] formed a cross-sectional investigation, including students among ten and seventeen years of age. They showed that there were with a mean age of 13.1 (+2.3) years with there were 454 boys (44.9%) with weight 44. 8 kg (12.9), and there were 557girls (55%) with weight of 45.7 kg (10.8).

In the current study, length varied from 102 to 165 centimeter with a mean value (± Stander Deviation) of 132.2 (±14.16) cm. Sitting length varied from 45 to 84 centimeter with a mean value (± Stander Deviation) of 64.2 (±9.41) cm. Leg length varied from 23 to 104 centimeter with a mean value (± Stander Deviation) of 68 (±11.97) cm.

In line with this investigation, **Regnault et al.**[7] observed that the mean of height was 128.8 cm.
Supporting our result, **Ma et al.**[11] showed that the mean value of length in male 139.3 cm however female was 139.8 cm. The mean leg length was 60.4cm.

length score was with median (IQR) -0.16 (-0.79 – 0.83). Sitting length was with median (IQR) -0.02 (-0.77 – 0.63). Leg length was with median (IQR) -0.17 (-0.67 – 0.58).

Systolic blood pressure ranged from 65 to 120 mmHg with a mean value (± SD) of 94.1 (±15.76) mmHg. Diastolic blood pressure ranged from 40 to 80 mmHg with a mean value (± SD) of 61.5 (±10.26) mmHg. Mean arterial blood pressure ranged from 48 to 93 mmHg with a mean value (± SD) of 72.3 (±10.29) mmHg.

In agreement with our results, **Cardoso and Leone.**[12]. conducted a sectional investigation of a randomized sample of 1,082 students of 6 to 7 and 9 to 10 years old utilized to assess BP and heigh. The mean SBP of the kids was 97.2 millimeters of mercury, (ninety five percent CI 96.5 to 97.8mmHg), and the mean DBP was 61.6 millimeters of mercury (ninety five percent 61.1 to 62.1 mmHg).

Our results revealed that there was a positive correlation among length and length score with (DBP and SBP). A positive correlation has been observed among sitting length and sitting length score with (DBP and SBP). A positive correlation has been observed among leg length and diastolic blood pressure. There was no association among leg length and systolic blood pressure. There was a positive association among leg length score and (DBP and SBP).

Taller children, on average, have higher BP than shorter kids, even following adjusting for other factors like age, gender, and body weight. This is thought to be due to the increased hydrostatic pressure required to circulate blood to the extremities in taller individuals. Additionally, taller children may have larger blood vessels and a greater blood volume, which can contribute to higher blood pressure [13].

Supporting our result, **Ejheisheh et al.**[14] illustrated that the height had great affect to SBP and DBP in females and males.

In line with our study, Jahan **et al.**[15] did a cross-sectional study on a total of 100 participants. The result showed that a significant positive association has been detected among pulse and blood pressure with height.

Also, **Dalayi and Chin.**[16] stated that there was positive association among BP (DBP and SBP) and sitting height.

In addition to our result, **Cochran et al.**[17] used a nationally representative information from the 6th Bangladesh Demographic and Health Survey (BDHS). The analyzation of information illustrated that height has been observed to be inversely correlated with PP in both genders.

In agreement with this study, **Ramoshaba et al.**[18] formed a cross-sectional investigation and observed that there was a positive association among body examinations with BP permits initial detection of elevated BP from sitting height throughout adolescence.

Conclusion

There was a positive association among height and BP in kids between 6-14 years old. There was a positive association among length and length score with DBP and SBP. Also, sitting length and sitting length score was correlated positively with DBP and SBP. A positive correlation has been observed among leg length and diastolic blood pressure. There was a positive correlation among leg length score and (SBP and DBP). There was no association among leg length and SBP.

Recommendations

- Since height and different body length measurements correlate positively with blood pressure, routine blood pressure monitoring should be conducted for children aged 6-14, particularly those experiencing rapid growth.
- Encourage balanced nutrition and regular physical activity to maintain optimal blood pressure levels, especially in growing children.
- Pediatricians and healthcare professionals should consider growth parameters such as sitting length, leg length, and overall height when assessing a child's risk for developing high blood pressure.
- Parents, schools, and caregivers should be informed about the relationship between growth and blood pressure to support healthy development and early intervention if needed.
- Apply study on patients of different ages.
- Apply study on larger sample size.
- Widing the area of this type of study.

Limitations

- The research depended on age 6 years to 14 years only not below 6 and above 14.
- The research was in a single center study area.
- The small sample size was relatively small.

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