# Optimizing Pediatric Blood Pressure Readings: The Role of Timing and Medical Personnel Presence: A cross-sectional study

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**Keywords.** Hypertension; Child; Blood pressure; White coat hypertension

**Introduction.** Hypertension is a major global health concern, playing a significant role in the development of cardiovascular diseases and other non-communicable conditions. Accurate blood pressure (BP) measurement is a key to its diagnosis. While guidelines recommend three BP readings with 1–2-minute intervals for adults, there is no clear consensus for children. Additionally, various factors, such as the presence of medical personnel, could impact BP readings. This study aimed to evaluate the impact of measurement timing and the presence of medical personnel on pediatric blood pressure readings.

**Methods.** In this analytical cross-sectional study, 50 children aged 5-13 years were enrolled. Blood pressure was measured using an automatic device with appropriately sized cuffs. BP was recorded at five intervals: baseline, 30, 60, 90, and 120 seconds. Measurements were taken both in the presence of medical personnel (attended) and without their presence (unattended). Data were analyzed using descriptive statistics and repeated measures ANOVA with IBM SPSS version 21.

**Results.** A significant decrease in systolic BP (SBP) was observed over time ($P$ = .000), with the initial SBP of 105.29 mmHg declining to 98.33 mmHg at 120 seconds. However, there were no significant changes in diastolic BP (DBP) or pulse pressure (PP) ($P$ = .400 and $P$ = .502, respectively). When comparing attended versus unattended measurements, both SBP and DBP were significantly higher when medical personnel were present ($P$ = .009 for SBP, $P$ = .010 for DBP).

**Conclusions.** The findings suggest that shorter intervals, such as 30 seconds, may be adequate for reliable BP measurement in children. However, the presence of medical personnel increases BP readings, likely due to anxiety. These results highlight the need to reduce stress during pediatric BP assessments to ensure accurate hypertension diagnosis and management.

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## INTRODUCTION

Hypertension (HTN) is a major global health concern, playing a significant role in the development of cardiovascular diseases and other non-communicable conditions.[1] Often referred to as the "silent killer" due to its asymptomatic nature, HTN can result in serious health complications if not properly managed. Despite this, blood

pressure is easily measurable using basic tools, and effective management is achievable through lifestyle modification and use of medications.[2] Accurate blood pressure measurement is essential for diagnosing HTN and preventing complications, particularly in children, where regular monitoring from age three is recommended.[3] Ensuring precision in blood pressure readings is crucial, as errors can lead to misdiagnosis, unnecessary interventions, or inappropriate treatments.[4]

As factors such as reliance on a single reading, the presence of healthcare personnel during measurement, and patient anxiety caused by the personnel's presence are known to influence results of BP measurements, assessing the impact of time intervals between repeated measurements and the presence of medical personnel during the procedure has gained attention.[5] Although guidelines promote standardized measurements to improve patient care, these can be time-consuming and resource-intensive in busy clinical settings.[6] It has been indicated that three readings with 1-2 minute intervals are recommended for adults; there is no clear consensus regarding shorter intervals.[7] or the role of personnel presence for children.

Although these factors have been extensively examined in adult populations,[8,9] evidence specific to children remains limited. This study contributes to the pediatric blood pressure measurement literature by focusing on two important yet unexplored variables—the interval between successive readings and the presence of medical personnel, both of which may significantly affect blood pressure results and contribute to white-coat hypertension in children. Despite widespread recognition of white-coat hypertension in pediatric care, most existing research and clinical guidelines are derived from adult-based protocols and do not adequately consider the distinct psychological and physiological responses of children. This study evaluates the impact of shorter measurement intervals and the absence of healthcare staff on the accuracy of readings, providing new evidence to support the development of more practical, child-appropriate, and resource-sensitive blood pressure assessment strategies. These findings have important implications for minimizing anxiety-related measurement distortions and enhancing the early identification and management of hypertension in pediatric age group.

## MATERIALS AND METHODS

### Patients and settings

This is an analytical cross-sectional study that was conducted on children referred to the 17th Shahrivar Pediatric Hospital between September 2023 and November 2023 in Iran. We used the convenience sampling method to collect participants. The inclusion criteria were age between 5-13 years, no previous history of smoking/ passive smoking, no previous history of underlying diseases including heart and hematological diseases, and not taking drugs that affect blood pressure. Exclusion criteria were as follows: children who were uncooperative or distressed during measurement, those who had consumed caffeine or engaged in vigorous physical activity within 30 minutes before measurement, and those who refused to continue at any time during the study process.

Based on the study by Juraschek *et al*.[8] and using the G Power software 3.1, the minimum sample size for the present study was estimated. The reported mean (± SD) systolic blood pressure values at 30 seconds and 60 seconds were 135.2 ± 18.1 mmHg and 137.7 ± 20.3 mmHg, respectively. A priori power analysis was conducted using a paired-sample t-test (Means: Difference between two dependent means) to determine the required sample size. The input parameters were: two-tailed test, effect size (dz) = 0.5, $\alpha = 0.05$, and power $(1-\beta) = 0.80$. The analysis yielded a required sample size of 34 participants (df = 33), with a critical t value of 2.035 and an actual power of 0.807. Considering a 20% dropout rate (approximately seven participants), the final minimum sample size was adjusted to 41 participants.

### Data gathering

Data were collected by a checklist comprising age, sex, height, weight, body mass index (BMI), systolic blood pressure, diastolic blood pressure, and pulse pressure. Height was measured by a Seca tape meter, and weight was measured using a Seca weight scale. BMI was calculated by dividing weight in kilograms by the square of height in meters for age and sex.

### Preparation

For measuring blood pressure, we complied with all 11 considerations that are important for assessing blood pressure in children.[10]

Blood pressure was measured using an appropriate cuff size by a Beurer automatic blood pressure measuring device, which is valid and accurate.[11]

### Assessing the duration of blood pressure measurement

Blood pressure was measured five times using the automatic blood pressure measurement method (AOBP) for each participant. Before starting the sequence of measurements, the participants rest for five minutes in a quiet environment. Then blood pressure was taken at baseline (first), 30 (second), 60 (third), 90 (fourth), and 120 (fifth) seconds following the first measurement.

### Attended vs. Unattended blood pressure measurement

The measurement was compared evaluated under two conditions: with and without the presence of medical personnel. In the attended type, the values of basic blood pressure (0) and 60 seconds (third) were used. To measure blood pressure values without the presence of the medical staff, after the first series of blood pressure measurements mentioned in the previous section, the cuff was removed from the child's arm and he/she was asked to shake his/her hand sufficiently and open and close the wrist to eliminate the compressive effect of the cuff on the limb vessels. The parents were taught how to work with the device to measure and record the results. After a five-minute break, the second series of measurements was performed in the absence of the medical staff in the form of two measurements. The systolic blood pressure in the absence of personnel was shown as SBP(U1) and SBP (U2). Also, the diastolic blood pressure in the absence of personnel was shown as DBP(U1) and DBP (U2).

### Ethical considerations

A written informed consent was obtained from all parents/legal guardians. This study was approved by the Ethics Committee of the Vice Chancellor of Research at Guilan University of Medical Sciences (codes: IR.GUMS.REC.1402.29 and IR.GUMS.REC.1402.288, approval Date: 2023-08-09).

### Statistical analysis

Data were reported by descriptive statistics (number, percent, mean, and standard deviation). We used the Kolmogorov–Smirnov test to assess the normality distribution of the quantitative data. Comparison of blood pressure values in different time intervals was done using repeated-measure ANOVA. A T-test was used to compare differences between attended and unattended results. *P*-value < .05 indicated statistical significance. Data were analyzed by IBM SPSS version 21 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp).

## RESULTS

In this study, 50 children with a mean age of 9.36 years (2.15) were assessed. The mean height, weight, and BMI of the participants were 133.84 cm (12.61), 33.62 kg (10.10), and 21.58 kg/m$^2$ (16.12), respectively. Assessing 350blood pressure readings, there was a decreasing trend in the mean SBP, DBP, and PP from the first to the fifth blood pressure measurement. (Table 1 and Figures 1-2). Repeated measure ANOVA showed significant differences in terms of SBP ($P$ = .00), but DBP ($P$ = .400) and PP ($P$ = .502) were not significantly affected by changes in time interval.

Comparing the effect of the presence and absence of medical personnel during blood pressure measurement, the base and 60-second measurements were compared. Our results indicated significantly

**Table 1.** Blood Pressure and Pulse Pressure Trends (Mean ± SD)

| Measurement Time Point | SBP (mmHg) | DBP (mmHg) | PP (mmHg) |
|---|---|---|---|
| Baseline | 105.29 ± 9.77 | 66.41 ± 7.55 | 38.83 ± 8.55 |
| 30 seconds | 101.77 ± 9.76 | 63.89 ± 8.23 | 37.58 ± 7.08 |
| 60 seconds | 99.79 ± 9.68 | 62.43 ± 8.62 | 37.35 ± 6.64 |
| 90 seconds | 98.58 ± 9.63 | 62.62 ± 8.98 | 35.95 ± 7.73 |
| 120 seconds | 98.33 ± 11.79 | 65.66 ± 12.12 | 32.81 ± 7.48 |
| Unattended 1 (U1) | 99.61 ± 11.24 | 63.42 ± 8.83 | 35.79 ± 9.03 |
| Unattended 2 (U2) | 99.14 ± 11.53 | 62.87 ± 9.60 | 37.70 ± 7.51 |

BMI: Body Mass Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, PP: Pulse Pressure, U: unattended measurements

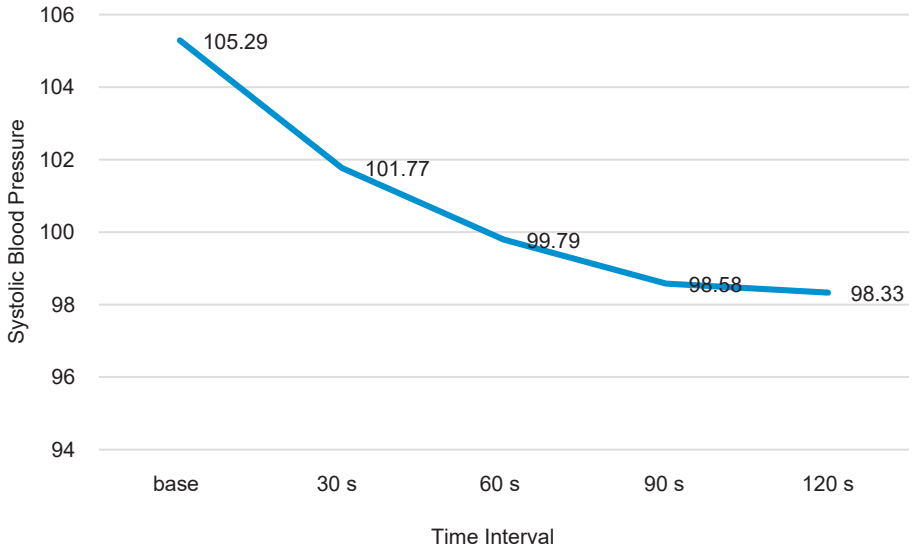


**Figure 1.** The trend of systolic blood pressure

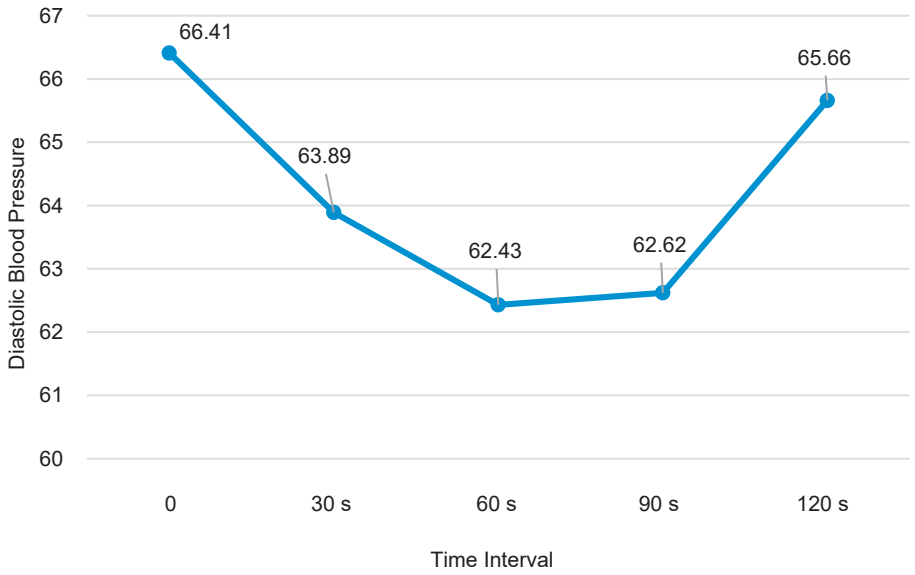


**Figure 2.** The trend of diastolic blood pressure

**2.** Comparing attended and unattended results

| Measure | Group | N | Mean Difference (mmHg) | Standard Deviation | 95% CI | *P* |
|---|---|---|---|---|---|---|
| Difference of SBP | Attended | 50 | 5.50 | 1.29 | 5.13 to 5.87 | .009 |
| | Unattended | 50 | 0.57 | 1.32 | 0.20 to 0.93 | |
| Difference of DBP | Attended | 50 | 3.98 | 0.79 | 3.76 to 4.20 | .010 |
| | Unattended | 50 | 0.52 | 1.06 | 0.21 to 0.84 | |
| Difference of PP | Attended | 50 | 1.48 | 1.56 | 1.03 to 1.93 | .114 |
| | Unattended | 50 | -1.92 | 1.45 | -2.35 to -1.49 | |

SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, PP: Pulse Pressure

higher SBP and DBP in attended situations than in unattended ones (Table 2).

## DISCUSSION

Hypertension in children is a serious health issue since it may result in cardiovascular and

kidney problems later in the future.[12] Therefore, accurate measurement of blood pressure is essential for identifying and managing excessive levels, especially in pediatric patients.[3,13] In our research, we evaluated SBP, DBP, and PP in children, highlighting the variation of these measurements over time. We also assessed whether the presence of healthcare professionals during the process had any influence on the results. Our study showed that SBP readings tended to decrease with repeated measurements. The initial SBP value was significantly elevated compared to the subsequent readings, indicating that children were gradually relaxed as the assessments continued. In contrast, DBP appeared to be relatively unaffected by repeated testing, as it remained almost constant throughout measurements. It is noteworthy that the SBP decline likely reflects reduced cardiac output due to relaxation (decreased sympathetic drive), while the DBP rebound may stem from compensatory arteriolar vasoconstriction to maintain perfusion pressure via increased peripheral vascular resistance. While we observed a slight downward trend in PP over time in attended situation and a slight increase in unattended one, this change wasn't statistically significant, indicating that PP might be less sensitive to the timing of repeated measurements compared to SBP.

The automated blood pressure device demonstrated acceptable accuracy in measuring both systolic and diastolic pressures, with minimal variability between repeated readings taken at zero-time intervals (i.e., immediately consecutive measurements). There was a high correlation between these multiple unattended readings, as indicated by the small mean differences—approximately 0.47 mmHg for systolic BP, 0.55 mmHg for diastolic BP, and 1.91 mmHg for pulse pressure—suggesting consistent and reliable performance without significant measurement error. Overall, the device showed good reproducibility under unattended conditions and no evidence of systematic error, although, consistent with findings from other automated monitors, it tended to yield slightly lower values in unattended measurements compared to attended ones.

The timing of blood pressure measurements plays a crucial role in obtaining accurate results.[14] In our study, reducing the interval between repeated measurements did not result in significantly altered blood pressure readings. This suggests that healthcare providers could use shorter intervals between readings, potentially saving time for both patients and staff while still maintaining accuracy. Shorter intervals might decrease the anxiety that children encounter during blood pressure evaluation, which can elevate their readings.

Imamura *et al.* demonstrated that a 30-second interval between blood pressure readings was sufficient to produce reliable values for both SBP and DBP in adults. They found that reducing the interval did not compromise the accuracy of the readings, challenging the traditional approach of using longer intervals.[9] Our findings are consistent with theirs, since SBP values in the children we examined stabilized after the initial 30-second interval. Although SBP showed a slight decrease with repeated measurements, no significant changes occurred after the 30-second mark, reinforcing the idea that shorter intervals can still yield consistent results.

Similarly, Jurashek *et al.* compared 30-second and 60-second intervals in hospitalized adults and found no significant difference in the accuracy of blood pressure readings between the two. Their research, which involved both automatic office blood pressure (AOBP) measurements and ambulatory blood pressure monitoring (ABPM), showed that while subsequent AOBP readings were lower than the first, the time interval between measurements had no significant effect.[8] This supports the notion that, under controlled conditions, shorter intervals do not adversely affect the reliability of blood pressure data. Collectively, these studies contest the belief that longer intervals are requisite for precise blood pressure measurement.[15,16] In clinical settings, it seems that employing shorter intervals—such as 30 seconds—could save valuable time while maintaining precision. This is particularly relevant in pediatric settings, where it can be difficult to keep children calm for long periods.

Furthermore, the slight increase in diastolic blood pressure (DBP) observed at the 120-second spot, following an initial decline, can be attributed to several physiological and procedural factors. One plausible explanation is the activation of autonomic compensatory mechanisms, such as the baroreflex, which may cause vasoconstriction and a mild increase in DBP to maintain circulatory stability.[17] Additionally, this increase may reflect a

return toward the baseline DBP value, indicating a physiological recovery phase after initial relaxation. Measurement variability due to device sensitivity, minor movements, or psychological factors such as anticipation or discomfort in pediatric participants could also contribute to this fluctuation.[7] Overall, the observed increase appears modest and falls within the expected range of normal physiological variability.

Our study also explored the impact of medical professional attendance on blood pressure measurement results. We observed significant differences in both SBP and DBP readings when compared attended and unattended measurements, with elevated values documented in the presence of healthcare .professionals This might be attributed to "white coat hypertension," where a patient's anxiety around medical staff leads to elevated blood pressure.[18] The children in our study may have experienced increased anxiety in the presence of a healthcare provider, leading to elevated results. Bauer *et al.* found no significant difference in blood pressure readings taken with or without medical staff present in adult patients. Their study, which focused on adults in general practitioner offices, revealed that automatic blood pressure measurements yielded comparable findings irrespective of the presence of medical personnel.[19] This suggests that children may respond differently to medical environments than adults do, especially younger children who might be more susceptible to anxiety in clinical settings, which could explain the elevated blood pressure readings in the presence of healthcare staff.

Bauer *et al.*'s findings underscored the importance of recognizing age-related variations in patient responses to clinical environments.[19] While adults may experience minimal anxiety during routine blood pressure checks,[20] children might be more susceptible to external stressors, such as the presence of unfamiliar medical personnel, leading to variations in their blood pressure readings. This distinction highlights the need for tailored approaches to blood pressure measurement in pediatric populations, possibly by minimizing environmental stressors or utilizing more child-friendly measurement techniques to obtain accurate readings.[21]

### Strengths and limitations

This study highlights the importance of repeated blood pressure measurements in children to obtain more accurate readings and suggests that the presence of healthcare personnel significantly affects the results. However, several limitations should be noted. Slight discrepancies in time intervals between attended and unattended measurements may have introduced variability, and unfamiliarity with digital devices among some parents could have contributed to measurement inconsistencies. In addition, autonomic and hemodynamic mechanisms were not assessed; parameters such as mean arterial pressure (MAP) and heart rate (HR) could have provided further insight and strengthened interpretation. Future research is required to investigate the impact of different time intervals, personnel presence, and autonomic/hemodynamic factors, particularly in pediatric populations, to enhance best practices for blood pressure measurement.

## CONCLUSIONS

The study revealed that shorter time intervals, such as 30 seconds, were sufficient for reliable BP measurement in children. However, the presence of medical personnel significantly increases BP readings, likely due to anxiety. These findings underscore the importance of minimizing stress during pediatric BP assessments to ensure accurate diagnosis and management of hypertension.

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