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# The Effect of Supine, Semi-Fowler's, and Fowler's Positions on the Blood Pressure Values of Patients Hospitalized in Surgical Clinics

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**Abstract**

**Aim:** Blood pressure measurement is an integral part of clinical practice in patient care and treatment, as well as being of critical importance in the early diagnosis, treatment, and prevention of the complications of hypertension. This study was carried out to determine the effect of Supine, Semi-Fowler's, and Fowler's positions on the blood pressure values of patients hospitalized in surgical clinics.

**Material and methods:** This quasi-experimental study was carried out with 112 preoperative surgical patients hospitalized in the surgical clinics of a training and research hospital. Using a bedside monitor, the patients' systolic and diastolic blood pressures were measured in the supine, Fowler's, and semi-Fowler's positions. The Pearson correlation coefficient, Mauchly's sphericity, ANOVA, and Bonferroni correction were used in the data analysis.

**Results:** While systolic blood pressure values did not differ between the Supine and Semi-Fowler's positions (F = .007, p = .934), there was a significant difference between the Semi-Fowler's and Fowler's positions (F =5.534, p = .020). Diastolic blood pressure values differed significantly between the Supine and Semi-Fowler's (F = 7.406, p = .008) and Semi-Fowler's and Fowler's (F = 9.038, p = .003) positions.

**Conclusions:** It is vital for nurses to establish procedures for blood pressure measurement and evaluation in the clinic and other team members and periodically revise the existing procedures.

**Keywords:** diastolic pressure, systolic pressure, posture, nursing, preoperative procedure.

## Introduction

Blood pressure (BP) measurement is an integral part of clinical practice in patient care and treatment. It is of critical importance in the early diagnosis, treatment, and prevention of the complications of hypertension [1]. The BP measurement is one of the most frequently used applications in interventional studies, public health research, and clinical examination and treatment [2]. The accuracy of BP measurement plays a vital role in preventing hypertension and reducing morbidity, which is a significant public health problem [3]. The prevalence of hypertension, which was seen in 1.13 billion people in Central and Eastern Europe in 2015, is 30-45%. It is estimated that this rate will increase by 15-20% by 2025 and reach 1.5 billion [4]. In Turkey, the prevalence of hypertension in the adult age group is 33%, as reported by the Turkish Society of Cardiology [5].

Many factors such as environmental factors (environmental temperature, noise, etc.), patient-related conditions (position, measurement area, physical activity status, eating and drinking status, smoking, caffeine consumption, etc.), diseases related to the measurement device (sensitivity of the device, cuff size, calibration status, etc.), measurement time, knowledge of the person making the measurement, and white coat effect can affect the BP measurement value [6, 7]. In general, differences

in BP measurement results from 1-2 mmHg to 20-50 mmHg can be seen in individual applications. Observing such significant differences as a result of the measurement may have effects that will change the care and treatment options of the patient [2]. In a study conducted in Canada and England, a systolic BP (SBP) of 3-5 mmHg increases the number of people diagnosed with hypertension by 24% to 43% [8]. Low BP measurements cause a delay in diagnosis and treatment, and high readings cause misdiagnosis and the start of incorrect treatment and diet [3, 9]. At this point, it is important to use procedures in blood pressure measurement. Various guidelines have been published with the aim of improving the accuracy of BP measurements by standardizing relevant procedures. These guidelines address measurements taken primarily from the upper arm and generally include recommendations regarding patient posture, cuff size, arm height, cuff descent rate, and number of repeated measurements [10].

In two studies conducted with physicians, when blood pressure was high, physicians tended to order more tests and evaluated patients' emotional problems [11-12]. There is no mention of an approach to how and where the nurse measures blood pressure. This shows that procedures for measuring blood pressure are needed. Generally, measurement values obtained from the upper arm are used in blood pressure evaluation. Although this standard technique seems simple, many consecutive steps are required to obtain a reliable result. Nurses and doctors often deviate from this technique [13]. A 5 mmHg difference in systolic blood pressure causes misclassification of hypertension status in 84 million people worldwide [14]. The recommended sitting position with arm and back support is not always clinically possible for various conditions or conditions such as pregnancy. It has been determined that clinically significant differences in blood pressure values may occur depending on patient position [15]. Therefore, it is clinically important to understand the effects of alternative patient positioning on blood pressure measurements.

In the literature review, the results of the studies on whether there is a difference between the semi-Fowler's, Fowler's, and supine positions, which are frequently used for BP measurement in clinical practice, are limited. Therefore, the present study was carried out to determine the effect of supine, semi-Fowler's, and Fowler's positions on the BP values of patients hospitalized in surgical clinics.

*Research Questions*

The research questions in our study were as follows:

- Do the supine, semi-Fowler's, and Fowler's positions affect the BP values of patients hospitalized in surgical clinics?
- Is there a difference between the measured SBP/diastolic BP (DBP) and the lowest and highest normal BP values?

## Material and methods

*Study Design and Sample*

This quasi-experimental study was carried out with surgical patients. They were hospitalized in the surgical clinics of a training and research hospital in Turkey's Eastern Black Sea region. The study population comprised 112 patients who were hospitalized in surgical units, including general surgery, urology, orthopedics and traumatology, ophthalmology, and neurosurgery between January and August 2021. The study's sample size was determined as 112 by conducting power analysis and taking the effect power as 0.80 and the effect size as 0.60.

The inclusion criteria were as follows:

- having no diagnosis of hypertension,
- having no cardiovascular disease,
- having body mass index (BMI) not greater than 45, and
- volunteering to participate in the study.

The exclusion criteria were as follows:

- using non-steroidal anti-inflammatory drugs,
- having communication problems,
- pregnant, and
- having skin lesions or limitation of movement in the arm and leg from which measurements will be obtained.

*Study Protocol and Data Collection*

Patients hospitalized in surgical clinics and who met the sampling criteria were first informed about the study. Those who agreed to participate in the study signed an informed consent form. Age, sex, height, weight, BMI, heart rate, and saturation value without BP measurement were recorded in the patients who met the sampling criteria and agreed to participate. Due to the COVID-19 pandemic, the patients were wearing masks but removed those five minutes before the oxygen saturation measurement, because a mask can affect the patients' saturation values, and then the values were measured. The research data were collected and recorded during the preoperative period. Some patients may have had limited mobility during the postoperative period, and positioning was difficult or contraindicated (hip and knee prosthesis operation, lumbar disc hernia, etc.). A calibrated and noninvasive bedside monitor was used for all BP measurements. A bedside monitor was chosen to avoid individual measurement differences and to use a standard device in the study. The bedside monitor was used to collect data only during the research implementation.

BP measurements as described in the 2018 Hypertension Management Guidelines of the European Society of Cardiology (ESC) were followed [4]. To determine the size of the cuff to be applied, arm circumference was measured, and the appropriate cuff was used for BP measurement (small <24, medium 24-34, large >34 cm). Before all measurements, the patients rested for at least 5 minutes. There was no conversation between the researcher and the patient during the measurement. There was no noise, and the room temperature was 21 °C. The patients wore loose comfortable clothes, and they did not cross their legs. If the patients had smoked or consumed food or any caffeinated drink before BP was due to be measured, the measurement was performed after waiting at least 30 minutes. BP values were obtained from both arms between 10 and 12 o'clock. If the difference between the measurements was more than 15 mmHg, the measurement was repeated. If there was more than a 15 mmHg difference between the two arms, the physician was told to evaluate the patient and not include him/her in the study sample. If the measurement difference was less than 15 mmHg, the higher measurement was recorded. First, measurements were made while the patient was in the supine position; then BP measurements were made by placing him/her in the semi-Fowler's and Fowler's positions. After the patient was moved into a different position and rested for 5 minutes, BP values were measured in the supine, semi-Fowler's, and Fowler's positions.

*Supine Position:* The patients had their legs extended straight, their arms at their sides, palms facing upwards, and their arms were supported by a pillow at heart level in the supine position. A cuff of appropriate size was placed on the brachial artery by palpation. SBP and DBP were measured in the supine

position in both arms. A third measurement was made and recorded if the difference was more than 5 mmHg between it and the previous ones. If the difference between the measurements was not more than 5 mmHg, the SBP and DBP in the higher BP arm were taken, and the mean BP value was calculated and recorded.

*Semi-Fowler's Position:* The patient's head was raised 45°, the back was supported by a pillow, and the legs were extended straight. The arms at heart level were supported by a pillow underneath, with the palms facing upwards. A cuff of appropriate size was placed on the brachial artery by palpation. In the BP measurement, SBP and DBP were taken in both arms in the semi-Fowler's position. A third measurement was made and recorded when there was a difference of more than 5 mmHg between it and the previous ones.

*Fowler's Position:* The patient's head was raised 90°, the back was supported by a pillow, and the legs were extended straight. The arms at heart level were supported by a pillow underneath, with the palms facing upwards. A cuff of appropriate size was placed on the brachial artery by palpation. The SBP and DBP were measured in both arms in the Fowler's position. A third measurement was made and recorded when there was a difference of more than 5 mmHg between it and the previous ones. When there was no difference between the measurements, SBP and DBP in the higher BP arm were recorded.

*Measurements/Instruments*

A questionnaire, which consisted of a Patients' Sociodemographic Form and a Physical Assessment Form, was used to collect the data. In the Patients' Sociodemographic Form, there were questions related to age, sex, marital status, family structure, residence, educational level, department, history of smoking, and current smoking. The Physical Assessment Form included weight, height, BMI, heart rate, respiratory rate, oxygen saturation, position, SBP, DBP, and arm circumference.

*Ethical Considerations*

The principles of the Declaration of Helsinki were considered at all stages of the study. It was explained to the participants that their personal information would not be shared with anyone, their identities would be kept confidential, and they could withdraw from the research whenever they wanted. For the implementation of the study, permission was obtained from the University Ethics Committee (05.12.2019/18). Written and verbal consent was obtained from the patients who participated in the study.

*Data Analysis*

IBM SPSS Statistics 25.0 (IBM, Armonk, NY, USA) was used to analyze the research data. Descriptive statistics such as number, percentage, arithmetic mean, standard deviation, and minimum and maximum values were used to analyze the descriptive data. The reliability of the scales was evaluated with the Cronbach alpha coefficient. The Shapiro–Wilk W test was used to assess the compliance of BP measurements with a normal distribution ($p>0.05$). Pearson's correlation coefficient test was used for the relationship between the measurements since the data showed a normal distribution. The sphericity assumption was tested with Mauchly's sphericity test and met ($p>0.05$). ANOVA was used in repeated measurements to determine the difference between BP measurements according to positions. Bonferroni correction was used for pairwise comparisons. A one-sample t-test was used to determine whether the SBP and DBP values obtained due to the measurements differed from the normal BP values. The lowest and highest normal BP values were obtained from the ESC and the ESH [4]. P values $< 0.05$ were regarded as statistically significant.

## Results

*Participants Characteristics*

The mean age of the patients was 48.91 ± 14.37 years, 54.5% were male, 84.8% were married, and 84.6% had a nuclear family structure. Moreover, 30.4% were primary school graduates and 36.6% were hospitalized in the general surgery service. Only 22.3% were smokers, while 43.8% were previous smokers. Of the participants, 44.6% were overweight (Table 1).

*Physiological Findings and Blood Pressure Measurements*

The mean heart rates of the patients were 75.89 ± 10.07, respiration rate was 18.03 ± 1.98, and oxygen saturation was 96.68 ± 1.66. The Fowler's position's mean SBP and DBP were 122.69 ± 12.27 and 75.89 ± 8.25, respectively. In the semi-Fowler's position, the mean SBP was 121.22 ± 12.31 and the mean DBP was 74.28 ± 8.87.

Table 1 Demographic characteristics of the patients

| Variables | n | % |
|---|---|---|
| Age (mean ± SD) | 48.91 ± 14.37 | |
| Gender | | |
| Female | 51 | 45.5 |
| Male | 61 | 54.5 |
| Marital status | | |
| Married | 95 | 84.8 |
| Single | 17 | 15.2 |
| Family structure | | |
| Nuclear | 106 | 94.6 |
| Extended | 6 | 5.4 |
| Place of residence | | |
| Village | 29 | 25.9 |
| Town | 36 | 32.1 |
| City | 47 | 42.0 |
| Educational status | | |
| Illiterate | 23 | 20.5 |
| Primary school | 34 | 30.4 |
| Secondary school | 19 | 17.0 |
| High school | 29 | 25.9 |
| University | 7 | 6.3 |
| Department | | |
| General surgery | 41 | 36.6 |
| Urology | 35 | 31.3 |
| Orthopedics and traumatology | 21 | 18.8 |
| Eye disease | 4 | 3.6 |
| Neurosurgery | 11 | 9.8 |
| Smoking | | |
| Yes | 25 | 22.3 |
| No | 87 | 77.7 |
| History of smoking | | |
| Yes | 49 | 43.8 |
| No | 63 | 56.3 |
| Body Mass Index (BMI) | | |
| ≤18.49 (underweight) | 2 | 1.8 |
| 18.50-24.99 (normal) | 31 | 27.7 |
| 25.00- 29.99 (overweight) | 50 | 44.6 |
| ≥30 (obese) | 29 | 25.9 |

The mean arm circumference was 27.08 ± 2.83. Considering the BP values, the mean SBP and DBP in the supine position were 121.16 ± 11.63 and 72.93 ± 9.01, respectively (Table 2). Figure 1 shows SBP measurements. Figure 2 shows DBP measurements. Figure 3 shows mean BP measurements.

Table 2 Physiological findings and blood pressure measurements

| Variables | Min. | Max. | Mean ± SD |
|---|---|---|---|
| Pulse | 44.00 | 102.00 | 75.89 ± 10.07 |
| Respiratory | 12.00 | 24.00 | 18.03 ± 1.98 |
| Oxygen saturation | 90.00 | 99.00 | 96.68 ± 1.66 |
| Supine systolic BP | 89.00 | 143.00 | 121.16 ± 11.63 |
| Supine diastolic BP | 53.00 | 99.00 | 72.93 ± 9.01 |
| Supine mean BP | 66.00 | 113.00 | 88.50 ± 8.83 |
| Semi-Fowler's systolic BP | 90.00 | 145.00 | 121.22 ± 12.31 |
| Semi-Fowler's diastolic BP | 53.00 | 93.00 | 74.28 ± 8.87 |
| Semi-Fowler's mean BP | 68.00 | 108.00 | 89.45 ± 8.80 |
| Fowler's systolic BP | 95.00 | 148.00 | 122.69 ± 12.27 |
| Fowler's diastolic BP | 53.00 | 96.00 | 75.89 ± 8.25 |
| Fowler's mean BP | 72.00 | 110.00 | 91.15 ± 8.34 |
| Arm circumference | 19.00 | 35.00 | 27.08 ± 2.83 |

*Correlation Findings*

Table 3 shows the correlation findings between the measurements. There was a positive and strong correlation between BP measurements in the supine position and those in the semi-Fowler's (r = 0.853) and Fowler's (r = 0.815) positions ($p < 0.05$). There was also a statistically significant strong correlation between BP measurements in the semi-Fowler's and Fowler's positions (r = 0.824, $p < 0.05$).

*Blood Pressure Measurements According to Positions*

There was a statistically significant difference between patients' SBP (F = 3.621, p = 0.028), DBP (F = 14.889, p < 0.001), and mean BP (F = 15.814, p < 0.001) measurements according to one-way ANOVA with repeated measures (Table 4).

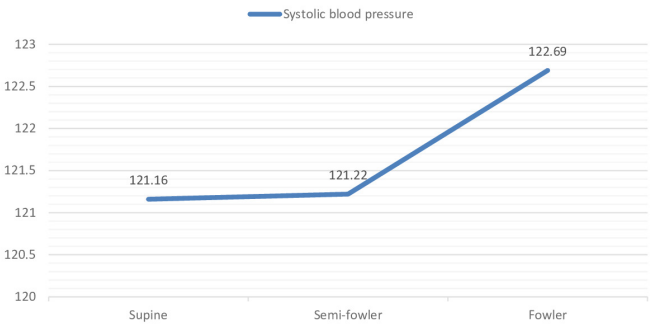


**Figure 1** – Systolic blood pressure measurements

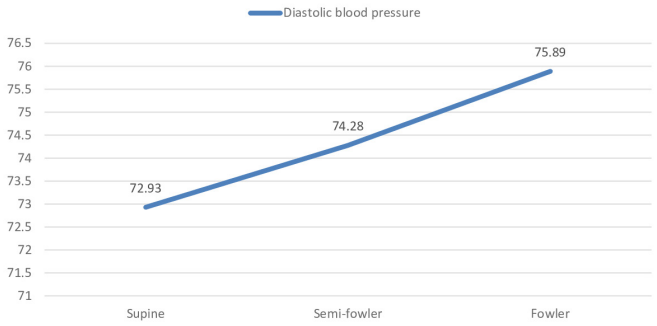


**Figure 2** – Diastolic blood pressure measurements

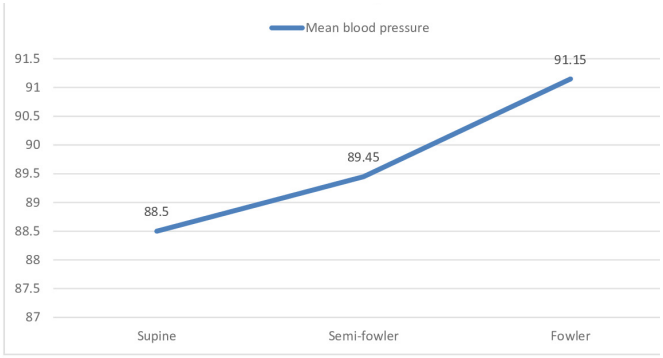


**Figure 3** – Mean blood pressure measurements

Table 3 Pearson correlation coefficient between blood pressure measurements

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Supine systolic BP (1) | 1 | | | | | | | | |
| Supine diastolic BP (2) | 00.621* | 1 | | | | | | | |
| Supine mean BP (3) | 00.853* | 0.914* | 1 | | | | | | |
| Semi-Fowler's systolic BP (4) | 00.839* | 0.531* | 0.740* | 1 | | | | | |
| Semi-Fowler's diastolic BP (5) | 0.560* | 0.828* | 0.788* | 0.607* | 1 | | | | |
| Semi-Fowler's mean BP (6) | 0.745* | 0.789* | 0.853* | 0.829* | 0.879* | 1 | | | |
| Fowler's systolic BP (7) | 0.831* | 0.489* | 0.709* | 0.855* | 0.533* | 0.724* | 1 | | |
| Fowler's diastolic BP (8) | 0.555* | 0.740* | 0.740* | 0.571* | 0.784* | 0.726* | 0.631* | 1 | |
| Fowler's mean BP (9) | 0.748* | 0.711* | 0.815* | 0.766* | 0.745* | 0.824* | 0.863* | 0.908* | 1 |

Table 4 Comparison of blood pressure measurements according to positions

| Position | Mean systolic BP | Mean diastolic BP | Mean BP |
|---|---|---|---|
| Supine position | 121.16 ±11.63 | 72.93 ± 9.01 | 88.50 ± 8.83 |
| Semi-Fowler's position | 121.22 ± 12.31 | 74.28 ± 8.87 | 89.45 ± 8.80 |
| Fowler's position | 122.69 ± 12.27 | 75.89 ± 8.25 | 91.15 ± 8.34 |
| F | 3.621 | 14.889 | 15.814 |
| p | 0.028 | 0.000 | 0.000 |

While SBP values did not differ between the supine and semi-Fowler's positions (F = 0.007, p = 0.934), there was a significant difference between the semi-Fowler's and Fowler's positions (F =5.534, p = 0.020). DBP values differed significantly between the supine and semi-Fowler's (F = 7.406, p = 0.008) and semi-Fowler's and Fowler's (F = 9.038, p = 0.003) positions (Table 5).

Table 5 Pairwise comparisons according to Bonferroni correction

| Blood pressure | Position | F | p |
|---|---|---|---|
| Systolic BP | Supine vs. Semi-Fowler's | 0.007 | 0.934 |
| | Semi-Fowler's vs. Fowler's | 5.534 | 0.020 |
| Diastolic BP | Supine vs. Semi-Fowler's | 7.406 | 0.008 |
| | Semi-Fowler's vs. Fowler's | 9.038 | 0.003 |
| Mean BP | Supine vs. Semi-Fowler's | 4.459 | 0.037 |
| | Semi-Fowler's vs. Fowler's | 12.338 | 0.001 |

Table 6 Comparison of the mean systolic and diastolic BP measured with the lowest and highest normal BP values

| Position | Systolic blood pressure | | | | |
|---|---|---|---|---|---|
| | Reference systolic blood pressure value | Measured systolic BP value | Mean difference | t | p |
| Supine systolic BP (1) | 1 | | | | |
| Supine diastolic BP (2) | 00.621* | 1 | | | |
| Supine mean BP (3) | 00.853* | 0.914* | 1 | | |
| Semi-Fowler's systolic BP (4) | 00.839* | 0.531* | 0.740* | 1 | |
| Semi-Fowler's diastolic BP (5) | 0.560* | 0.828* | 0.788* | 0.607* | 1 |
| Semi-Fowler's mean BP (6) | 0.745* | 0.789* | 0.853* | 0.829* | 0.879* |
| Fowler's systolic BP (7) | 0.831* | 0.489* | 0.709* | 0.855* | 0.533* |
| Fowler's diastolic BP (8) | 0.555* | 0.740* | 0.740* | 0.571* | 0.784* |
| Fowler's mean BP (9) | 0.748* | 0.711* | 0.815* | 0.766* | 0.745* |

In Table 6, the mean SBP and DBP measured with normal BP values are compared. There was no significant difference between the normal SBP value and the supine and semi-Fowler's SBP values ($p = 0.290$, $p = 0.295$, respectively). In addition, although the SBP value in the Fowler's position was significantly higher than the normal value ($p = 0.022$), it was lower than the highest value considered normal ($p < 0.001$). There was a statistically significant difference between normal DBP and supine, semi-Fowler's, and Fowler's BP values ($p < 0.001$).

## Discussion

In our study, the SBP value in the supine position was lower than the values in the semi-Fowler's and Fowler's positions. The SBP value was highest in the Fowler's position. According to the ESC and ESH, the optimal BP value is <120 mmHg for SPB [4]. While there was no difference between this value and the average of the measurements made in the supine and semi-Fowler's positions, the value obtained in the Fowler's position was higher than the optimal value. According to the ESC and ESH, the highest SBP value considered normal is 129 mmHg [4]. Based on this value, the average of the measurements in the supine, semi-Fowler's, and Fowler's positions was low. The reference value for a normal systolic blood pressure is 120 mmHg [16]. They stated that BP might vary according to whether the patient is lying down, sitting, or standing. In this case, the SBP values measured according to the positions (120-129 mmHg) were accepted as normal by the ESC and ESR [4]. However, a 120-129 mmHg SBP is considered a risk for high BP and hypertension [17, 18]. Therefore, choosing the position with the lowest SBP in the measurement may be essential along with always using the same position.

In the present study, when the DBP measurements in the three different positions were compared, DBP was lowest in the supine position and highest in the Fowler's position. The lowest and highest DBP values that are considered normal according to the ESC and ESR are 80-84 mmHg [4]. DBP values obtained in the supine, semi-Fowler's, and Fowler's positions in the present study were low compared to both values considered normal. Other vital signs of the patients were in the normal range, and it can be concluded that the patient's condition is stable. In this case, the normal DBP value may need to be reconsidered for hospitalized patients, because an increase in DBP above 10 mmHg doubles the risk of death from cardiovascular disease [19]. Therefore, it may be beneficial for nurses to review BP values and establish BP measurement and evaluation procedures.

In the present study, the SBP and DBP values generally differed according to the positions, and the values in the Fowler's position were higher than those in the other positions. Similar to our study, Myers et al. [15] found that SBP, DBP, and mean BP values were lower in the supine position compared to in the Fowler's position. However, Eşer et al. [20] found that SBP showed a significant difference according to position, while DBP values did not change. The SBP in the supine position was higher than that in the other positions. In a study comparing brachial and aortic BP values according to sitting and supine positions, SBP was more increased in the supine position, while DBP was higher in the sitting position [21]. In another study, while there was no difference in patients' systolic blood pressure values according to the Semi-Fowler position, there was a significant increase in the Supine position [22]. Like the present study, Privsek et al. [23] found that both SBP and DBP values in the sitting position were higher than those in the supine position. As can be seen, the study findings differ. Based on the results of our study, the position given to the patient during BP measurement is important. In addition, measuring BP in the same position during the treatment and care of the patient may prevent differences that may occur in the measurement results and the wrong treatment and interventions applied accordingly.

BP measurements are affected by physiological factors such as the patient's emotional state, body temperature, respiration rate, bladder distension, pain, exercise, age, food consumption, tobacco and alcohol use, and medical conditions [24]. One study compared doctors, nurses, and nurse assistants and found that knowledge of accurate blood pressure measurement was higher in doctors [25]. Freire et al. [26] found that factors affecting BP values are adiposity, glycemia, smoking, physical activity, alcohol consumption, and socioeconomic status. These factors make it difficult to measure BP accurately. However, it can be beneficial to identify and control controllable factors such as exercise, food, and position. In the present study, factors such as measuring instrument, cuff size, speech, noise, temperature, position, clothing, food, smoking, tea, caffeinated food, and measurement techniques were kept under control during the measurement.

## Limitations of the Study

The study has some limitations. It was conducted in a single center. Therefore, it cannot be generalized to the whole universe. Future studies may be undertaken in larger samples and more than one center. Measurements were automatically measured using a bedside monitor. Comparative studies on manual and automatic measurement can be conducted.

## Conclusion

In the present study, the supine, semi-Fowler's, and Fowler's positions that hospitalized patients were placed in significantly affected SBP and DBP measurements, and the measurement values were different. BP measurements should always be made in the same position during the hospitalization of patients for an accurate evaluation. More studies are needed on the effect of positions on BP and the reference range in which BP values will be evaluated. It is vital for nurses to establish procedures for BP measurement and evaluation in the clinic and other team members and revise the existing procedures periodically. In addition, since two or more measurement methods are not routinely performed in clinical practice, it is essential to inform nurses about the measurement strategy and emphasize this issue in training. Meticulous evaluation and control of the factors affecting BP will also contribute to accurate BP measurement.

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