Differences in Blood Pressure according to Body Position by Age Groups

Mi Ryeong Song¹, Young-Shin Lee²

¹Associate Professor, Department of Nursing, Hoseo University, Asan, Korea; ²Associate Professor, School of Nursing, San Diego State University, California, USA

연령별 신체자세에 따른 혈압의 차이분석

송미령¹, 이영신²

¹호서대학교 간호학과 부교수, ²샌디에고 주립대학교 간호대학 부교수

목적: 이 연구의 목적은 성인의 연령군별 축정자세 변화에 따른 혈압의 변화 정도를 살펴보기 위한 것이다. 방법: 이 연구는 담색적 조사연구로서 연구대상자는 20세에서 59세까지 성인 136명을 대상으로 만성질병이 없고 연구 목적과 연구방법에 대한 설명을 듣고 연구 참여에 동의한 자를 대상으로 하였다. 수집된 자료는 연령군을 나누어 양와위, 좌위, 직립위에서 혈압의 차 이를 paired t-test로 분석하였으며, 연령군에 따라 운동여부와 건강상태에 차이가 있었으므로 연령과 축정자세기에 따른 혈압 변화의 상호작용을 확인하기 위해 repeated measure ANCOVA를 실시하였다. 결과: 초기 성인군(20대와 30대)에서는 자세의 변화에 따른 수측기 및 이완기 혈압의 변화가 없었으나40대와 50대에서는 수측기 혈압에서 양와위에 비해 좌위(p<.001)와 직립위(p<.001, p=.001)에서 유의한 감소가 있었다. 수측기(p=.004)와 이완기(p=.019) 모두에서 연령과 축정자세에 따른 혈압 변화에 유의한 상호작용이 있어 연령군에 따라 자세로 인한 혈압의 변화에 유의한 차이가 있는 것으로 나타났다. 결론: 40세 이후에는 혈압측정시에 자세를 기록하는 것이 중요하며 중년기 이후 자세의 변화에 따른 혈액동의 변화에 특별한 주의를 기울일 필요성이 있다.

Key Words: Blood pressure; Patient positioning; Supine position; Age groups

国문주요어: 혈압, 환자 자세, 앙와위, 연령군

INTRODUCTION

Accurate measurement and recording of blood pressure (BP) has become more important in a multidisciplinary health care environment. BP reflects physiologic conditions and monitors critical changes (Pickering et al., 2005). It can be correctly gauged by trained persons such as registered nurses with special skills, knowledge, and awareness of the correct process (Dickson & Hajjar, 2007). Traditional measuring of BP, as well as other vital signs, has been a fundamental task of nurses (Potter & Perry, 2005). However, while multidisciplinary care personnel in a complex health care system are allowed to measure BP, the accuracy of BP readings has been a concern.

The literature reveals several concerns about yielding accurate BP with regard to knowledge, skills, procedure, and recordings (Pickering et al., 2005). Some studies have shown that recorded BP measurements seemed to be inaccurate (Armstrong, 2002; Kim & Kim, 2000), and determinations for systolic and diastolic turning points of BP were not accurate (Pickering et al., 2005). Phase 1 (systolic) and Phase 5 (diastolic) Korot-
Differences in Blood Pressure according to Body Position by Age Groups

The purpose of this study was to identify differences in BP changes according to body position by age groups. In order to accomplish this objective, the study hypothesized the following:

1) There will be differences in SBP and DBP according to body position.
2) There will be differences in the change of SBP and DBP according to different body positions by age groups.

METHODS

1. Research design

This study used an explorative cross-sectional design to identify whether SBP and DBP are changed by body position among different age groups among 136 South Korean adults.

2. Sample and settings

The data were collected from September through November, 2008 in a university laboratory room. Adults who expressed a willingness to participate in the research study were provided with a description of the purpose and method of this study, and then they signed a consent agreement to participate. A power analysis indicated that a sample size of 136 had a 99% power in the medium effect size (f = 0.25), with the number of groups 4, at α = .05 (Fall, Erdfelder, Buchner, & Lang, 2009).

Participants in the study were above twenty years of age and had no medical diagnoses. Among the potential participants, some were excluded. Exclusion criteria were as follows.

- Those whose arm circumference was ≤ 23 cm or ≥ 33 cm so that an adult cuff with a width of 12 cm could be used, the size deemed the most appropriate for measurement in Korea (Kim et al., 2005)
- Those who had smoked or consumed alcohol 30 minutes prior to measuring BP
- Those who had no diagnosis of hypertension
Those who were not taking any prescribed medications

3. Measurements

1) Blood pressure

Blood pressure was measured with a calibrated V-LOK sphygmonanometer (Baumanometer®, W.A. Baum Co. Inc., Copiague, NY) in accordance with the proper guidelines (National Heart, Lung, and Blood Institute, 2000). The cuff was inflated by pressing the valve until the blood flow stopped and then was deflated slowly while the researcher watched the aneroid indicator and simultaneously listened to the sound of the blood pumping through a stethoscope. Blood pressures were measured from 2PM to 5PM in order to take into account daily changes in BP. Participants rested on a chair for 5 minutes in a laboratory room before having their BP taken. To decrease sampling errors, a sphygmonanometer was located at the level of the heart according to body position (Pickering, et al., 2005). A cuff was applied 2-3 cm above the palpation site on the brachial artery on the right arm.

The nurse elevated the pressure until the pulse could not be palpated and then deflated the cuff. After pausing for 60 seconds, the nurse re-inflated the cuff pressure over 30 mmHg above the reading point, and read the number on the mercury barometer at eye level while the cuff pressure was deflated at a velocity of 2-4 mmHg a second (Potter & Perry, 2005). Sounds were classified into 5 phases: Phase 1 and 5 were used for recording systolic and diastolic BP (Pickering et al., 2005). Blood pressure was read in millimeters of mercury (mmHg) and was recorded as SBP and DBP. An individual’s BPs was measured in the following same order.

• The process was explained to the participants.
• BP was measured in the supine position.
• The participants rested for 2 minutes (Potter & Perry, 2005).
• The participants then sat on a chair and had their BP taken.
• The participants rested for 2 minutes.
• The participants stood up and had their BP taken within 2 minutes.
• Each participant was informed of the conclusions of the observations, and their general characteristics were recorded.

2) General characteristics

General characteristics included age, gender, exercise activity, and health status. Age was classified into four groups: 20 to 29, 30 to 39, 40 to 49 and 50 to 59 years. Level of exercise was defined by the answer to the question: “1) Do you exercise?” and the responses were simply recorded as ‘yes’ or ‘no’. Self-reported health status was determined by the answer to the question: “How do you rate your current health status?” with five options given: very good, good, ordinary; not good and bad. No subject answered: “Bad.” Responses were classified into two groups: good (very good, good), average (ordinary, not bad).

4. Data analysis

The collected data were analyzed using the SPSS WIN14.0 program. Descriptive statistics (frequency and percentage) were used to obtain characteristics for gender, exercise level, and health status and a Chi-square analysis was used to determine the differences between groups (men and women, exercisers vs. non-exercisers, health status) by age. A paired t-test was used to yield differences in BP between supine position, the sitting position and the standing position in each age group. Since BP data were not satisfactory for sphericity conditions, Greenhouse-Geisser’s error compensation of degree of freedom was applied. Since the exercise engagement and the level of health status were differ by age groups, a MANOVA (Repeated measure ANCOVA) was used to determine the overall main and interaction effect for BP. Differences were considered significant when the p value of the position by group interaction effect was less than .05.

5. Ethical considerations

The subjects participated in this study voluntarily after hearing an explanation about the purposes and the processes of the study. The subjects were informed that they had the right to refuse to participate, that they could stop participating at anytime during the study, that their confidentiality would be respected, and that they could expect some reward for participating in the study. The subjects then signed an agreement consenting to participating in the study. And then the study proceeded on the basis of the consent given and with the dignity of the participants respected at all times.

RESULTS

1. General characteristics of participants

Of the 136 participants, 47 were aged 20 to 29 years, 18 were aged 30 to 39, 41 were aged 40 to 49, and 30 were aged 50 to 59. 58 were male and 78 were female. 58.1% of the total reported engaging in some exercise and
55.1% felt their health conditions were good. Results of the Chi-square test showed no significant differences between men and women, and health status between the four age groups (young and old). With regard to exercise, 94.4% of the 30 to 39 age group answered "yes" to the question whether they engaged in exercise or not, while 46.8% of the 20 to 29 age group answered "yes." More than half of the participants answered the question about health status with the response 'good' (Table 1).

2. Differences in BP status according to body position

The overall averages of SBPs were 117.02 mmHg (SD = 9.99), 115.24 mmHg (SD = 9.76), and 114.85 mmHg (SD = 9.76) for the supine, sitting, and standing positions, respectively. The SBP measurements for the sitting (p < .001) and standing positions (p < .001) were significantly lower than those for the supine position (Table 2). The hypothesis that there would be differences in SBP resulting from different body positions was accepted.

The overall averages of DBPs were 73.11 mmHg (SD = 7.60), 72.78 mmHg (SD = 6.96), and 72.82 mmHg (SD = 6.77) for the supine, sitting, and standing positions, respectively. The SBP measurements for the sitting (p < .001) and standing positions (p < .001) were significantly lower than those for the supine position (Table 2). The hypothesis that there would be differences in DBPs according to body position was discarded at a significance level of .05.

3. Differences in BP status by age

In the 20 to 29 group, average SBPs were from 113.80 to 113.87 mmHg and the average DBPs were between 69.99 mmHg and 70.39 mmHg for the supine, sitting, and standing positions. In the 30 to 39 group, average SBPs were from 115.22 to 113.89 mmHg and the average DBPs were between 71.94 mmHg and 72.14 mmHg for the supine, sitting, and standing positions. There were no statistical differences in both SBP and DBP with regard to changes in body position in the younger groups (Table 2).

In the 40 to 49 group, average SBPs were 118.28, 116.46, and 114.63 mmHg, and average DBPs were 75.29, 75.66, and 74.29 mmHg for the supine, sitting, and standing positions respectively. In the 50 to 59 group, average SBPs were 121.43, 117.90, and 117.23 mmHg, and average DBPs were 76.80, 75.47, and 75.00 mmHg for the supine, sitting, and standing positions respectively. In contrast to the younger group, the older group's average SBPs were statistically significantly lower for the sitting (p = .007 in 40 to 49, p < .001 in 50 to 59) and standing positions (p < .001 in 40 to 49, p = .001 in 50 to 59) in comparison with the supine position. For the average DBPs, the BP in the 50 to 59 age group was significantly lower in the standing position (p < .05) than in the spine position, but not in the sitting position.

The hypotheses that there would be differences in SBPs and DBPs by position and age were partially accepted with regard to the older age group.

Table 1. Characteristics of Participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Classification</th>
<th>Total n (%)</th>
<th>20-29 (n = 47)</th>
<th>30-39 (n = 18)</th>
<th>40-49 (n = 41)</th>
<th>50-59 (n = 30)</th>
<th>χ² (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>78 (57.4)</td>
<td>24 (51.1)</td>
<td>14 (77.8)</td>
<td>24 (58.5)</td>
<td>16 (53.3)</td>
<td>4.052 (.256)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>58 (42.6)</td>
<td>23 (48.9)</td>
<td>4 (22.2)</td>
<td>17 (41.5)</td>
<td>14 (46.7)</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>Yes</td>
<td>79 (58.1)</td>
<td>22 (46.8)</td>
<td>17 (94.4)</td>
<td>23 (56.1)</td>
<td>17 (56.7)</td>
<td>12.320 (.006)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>57 (41.9)</td>
<td>25 (53.2)</td>
<td>1 (5.6)</td>
<td>18 (43.9)</td>
<td>13 (43.3)</td>
<td></td>
</tr>
<tr>
<td>Health status</td>
<td>Good</td>
<td>75 (55.1)</td>
<td>33 (70.2)</td>
<td>8 (44.4)</td>
<td>17 (41.5)</td>
<td>17 (56.7)</td>
<td>8.278 (.041)</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>61 (44.9)</td>
<td>14 (29.8)</td>
<td>10 (55.6)</td>
<td>24 (58.5)</td>
<td>13 (43.3)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Comparison of Blood Pressure According to Body Position

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>n</th>
<th>Supine (Referent)</th>
<th>Sitting</th>
<th>Standing</th>
<th>DBP (mmHg)</th>
<th>Supine (Referent)</th>
<th>Sitting</th>
<th>Standing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
</tr>
<tr>
<td>20-29</td>
<td>47</td>
<td>113.80 ± 7.99</td>
<td>112.87 ± 9.17</td>
<td>113.87 ± 9.87</td>
<td>69.99 ± 7.74</td>
<td>68.77 ± 5.82</td>
<td>70.39 ± 6.33</td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>18</td>
<td>115.22 ± 10.79</td>
<td>114.17 ± 11.34</td>
<td>113.89 ± 8.79</td>
<td>71.94 ± 7.44</td>
<td>72.22 ± 7.47</td>
<td>72.14 ± 7.49</td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>41</td>
<td>118.28 ± 11.08</td>
<td>116.46 ± 9.97</td>
<td>114.63 ± 10.69</td>
<td>75.29 ± 6.46</td>
<td>75.66 ± 6.73</td>
<td>74.29 ± 6.76</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>30</td>
<td>121.43 ± 9.19</td>
<td>117.90 ± 8.85</td>
<td>117.23 ± 8.80</td>
<td>76.80 ± 5.88</td>
<td>75.47 ± 5.58</td>
<td>75.00 ± 6.01</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>136</td>
<td>117.02 ± 9.99</td>
<td>115.24 ± 9.76</td>
<td>114.85 ± 9.76</td>
<td>73.00 ± 7.60</td>
<td>72.78 ± 6.96</td>
<td>72.82 ± 6.77</td>
<td></td>
</tr>
</tbody>
</table>

*p < .01; †p < .001; ‡p < .05.

SBP = systolic blood pressure; DBP = diastolic blood pressure.
but not for the younger age group (Table 2).

4. Differences in BP status by body position and age

Results of the MANOVA revealed significant effects caused by body position and age and significant interaction between age groups by body position with regard to SBPs and DBPs (Table 3, Figures 1, 2).

With regard to SBP, there was an interaction according to age and position change (F = 4.63, p = .004). With regard to DBP, there was an interaction according to age and position change (F = 3.42, p = .019). The hypothesis that there would be a difference in the level of BP change according to position by age groups was accepted.

These findings indicate that there is an interaction between age and position change with regard to both SBP and DBP. So, we know the level of change with regard to BP is different according to position by age groups (Table 3). In fact, we can see the differences according to age group. The younger age group didn’t reveal any change in SBP, as seen in the graph, but the older age group revealed a notable decrease in SBP, as seen in the graph. Also, there was a different feature in the BP curve for DBP (Figures 1, 2).

### DISCUSSION

In our study, the older group, aged over 40, revealed significant BP changes in SBP by positions (from supine to sitting to standing) which is consistent with the findings of the study conducted by Netea et al. (2003), which postulated that most hypertensives are middle aged or elderly adults. On the other hand, the BP changes in the young adult group were different in comparison with previous studies. The younger age group in our study revealed no significant changes in both SBP and DBP by position changes, while healthy university students had significant changes in their SBP by position change according to Eser et al. (2007). As age and hypertension are very important factors in the mechanism associated with blood pressure change, comparisons between studies involving different age groups and participants with different diseases must be tentative. Further research study targeting young adults is needed to clarify the results.

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**Figure 1.** SBP change according to body position by age groups.

**Figure 2.** DBP changes according to body position by age groups.
With regard to the analysis of repeated ANCOVA reflecting age and position, BP changes could be better demonstrated. SBP was significantly different by position, and interaction between age and position, which indicates that SBP is sensitive to changes in body position as well as age. This is consistent with research findings (Kusuma, Babu, & Naidu, 2001). In particular, SBP readings in the older age groups were more sensitive in relation to position than among the younger age groups. This result can be explained by the change in pathophysiologic phenomena, that is, individuals have decreased vasmotor sympathetic responsiveness as they get older as well as weaker large and small vessel compliance. In addition, individuals experience increased vascular resistance as they age (Barnett et al., 1999; Hyoung & Kim, 2008; Weinberger, Fineberg, & Fineberg, 2002). In the published literature, older women have a wide range of BP variability that can put them at high risk for end-organ damage such as silent cerebrovascular damage (Jaquet, Goldstein, & Shapiro, 1998; Song, Park, & Hwang, 2004). Therefore, detecting BP changes, even small differences, is important to prevent the further progress of diseases.

With regard to body position, there are several studies that reveal BP changes between the supine, sitting, and standing positions. Studies have shown that SBP becomes lower by approximately 8 mmHg when individuals change their position from lying down to sitting or standing (Eser et al., 2007; Terent & Breig-Asher, 1994).

Even in the sitting position, the place where the person sits influences blood pressure. Sala, Santin, Rescalndani, Cuspidi, & Magrini (2004) reported that SBP and DBP readings in elderly people with mild hypertension were overestimated in the bed-seated position in comparison with the recommended chair-seated position. Turner et al. (2008) reported a significant influence on SBP when measurements were taken while participants were seated in a chair with both feet resting on the floor - lower than measurements taken when participants were seated on an exam table with legs dangling and without back support. However, no significant differences existed in DBP changes over time in either the chair seated or exam table seated positions.

In our research, the gap in SBP in older groups between supine and standing positions was approximately 4mmHg. This small difference in comparison to previous reports can be explained by the age scope of the participants - aged 40 to 59 years - which is a middle aged group rather than a group of elderly individuals, who usually evidence more characteristics of high BP than young or middle age groups. However, it can exacerbate the process of orthostatic stress as age increases.

Orthostatic hypotension could be related to the increase in orthostatic stress among older adults. Orthostatic hypotension is another common problem among older adults and the positive correlation between postural hypotension and old age is well known (Medow et al., 2008). A study conducted with adults in middle age (45-64 years old) showed that those who had a greater gap in SBP between supine and standing had a 15% greater prevalence of hypertension, and a 22% greater prevalence for peripheral vascular disease and congestive heart disease than those who had relatively small changes (Nardo et al., 1999).

Our findings and the literature suggest that health care providers need to pay attention to those who show a decrease in SBP by position change, especially in the age group over 40 in order to detect early hypertension and prevent orthostatic hypotension.

**CONCLUSION**

This is an explorative study to identify differences in SBP and DBP according to body position and also differences in the level of change in blood pressure according to body position by age groups. The participants included 78 females and 38 males, 65 younger age participants (20 to 39) and 71 older age participants (40 to 59). There were no statistical differences within the younger age groups for SBP and DBP. In contrast, there were significant differences in SBP and DBP according to body positions within the older age groups. Finally, there is a significant interaction effect between age and change in position for both SBP and DBP.

Recording positions during the measurement of BP is important, especially in subjects aged over 40. Special attention needs to be paid when observing hemodynamic change that results from changes in position during the measurement of BP in those over 40 years of age. Further research on hemodynamic change in relation to people with various health problems, especially conditions such as cardiovascular disease, is needed.

**REFERENCES**


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