Effects of Confounding Factors on Blood Pressure in Hypertensive Patients: A Cross Sectional Study

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Research Article

Keywords: hypertension, blood pressure, confounding factors

DOI: https://doi.org/10.21203/rs.3.rs-283642/v1

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Abstract

Background

Blood pressure is influenced by biopsychosocial factors such as physical, environmental, emotional, cognitive and behavioral in hypertensive patients.

Objective

The aim of this study is to investigate confounding factors in hypertensive patients who have poor blood pressure control.

Design

This study was designed as a cross-sectional study.

Participants

Our sample was 407 patients with hypertension in Rize, a Northern city in the Black Sea Region of Turkey. In study group, there were 207 hypertensive patients who had admission to emergency department due to high blood pressure. In control group, there were 200 hypertensive patients visiting family physician, who defined themselves as having regulated blood pressure over the past six months.

Main Measures

Patients completed the questionnaire including sociodemographic data, lifestyle behaviors, health risks and confounding factors via the face-to-face interview method.

Key Results

Of the hypertensive patients, 81.2% (n=168) of the study group and 34.0% (n=68) of the control group had confounding factors. There was a significant difference between the hypertensive patients of study and control group in terms of their confounding factors (p<0.001). When we asked the patients of study group questions to reveal their confounding factors, 21.3% (n=44) stated ‘anger’, 12.6% (n=26) ‘sadness’, 11.1% (n=23) ‘anxiety’, 10.6% (n=22) ‘depressed’, 9.2% (n=19) ‘unhealthy diet’, 7.2% (n=15) ‘fatigue and poor sleep quality’, and 3.9% (n=8) ‘irregular medication’. Mean systolic and diastolic blood pressure were significantly higher in hypertensive patients having confounding factors than those without confounding factors (p=0.001, p=0.001, respectively). Mean systolic blood pressure of hypertensives who stated their confounding factor as ‘anger’ was significantly higher than those the remaining groups (p<0.001).

Conclusions

This study has shown that confounding factors impair blood pressure control in patients with hypertension. Confounding factors should be kept in mind and revealed in case of poor blood pressure control in hypertensive patients.
Introduction

Hypertension is the most common condition seen in primary care and leads to myocardial infarction, stroke, renal failure, and death if not detected early and treated appropriately. (1) A recent analysis of data from European registries (2) has shown that on average only 39% of hypertensive patients achieve an adequate blood pressure (BP) control. Improvement in BP control rates is probably one of the most beneficial steps that can improve life expectancy and the quality of life for millions of people with immediate and measurable results. The lifetime burden of hypertension remains substantial and highlights the need for new strategies. (3)

There are studies explaining the negative effect of many reasons/factors on BP control. Among these reasons/factors, late or ineffective treatment, leading to irreversible or difficult to reverse adaptations of the cardiovascular system, may play a role. (4) Smoking is also one of these factors. Patients without a history of tobacco use had faster and better BP control than current or former tobacco users. This finding is concerning because of the increased cardiovascular risk associated with tobacco use. (5, 6) Lower income is another factor. Patients with higher income have better control of BP. Lower income may be associated with increased risk for mental disorders. (7) Modifiable risk factors including lack of physical exercise and adding salt into meals were significantly and independently associated with poor BP control. (8) Higher BP was associated with higher alcohol consumption, higher body-mass index, diet high in sugar-sweetened beverages and diet high in sodium. (9) A study which investigated BP, sleep quality and fatigue in shift-working police officers showed that there was a significant increase in systolic BP after shift work, while BP and fatigue levels were strongly related. (10)

BP is influenced by biopsychosocial factors such as physical, environmental, emotional, cognitive and behavioral in hypertensive patients. (11) Pessimistic and anxious adults had higher BP levels and felt more negative and less positive than did optimists or low anxious adults. (12) Happiness, anger, and anxiety increase BP to differing degrees and emotional effects may be greater with more labile BP. (13) A meta-analysis supported that depression was probably an independent risk factor for hypertension as a confounding factor. (14) Emotional state (happiness, anger, or anxiety) significantly contributed to the variation of BP in this sample of borderline hypertensive patients. The comparison of the pressures during each reported emotional state show that anger and anxiety increase BP more than happiness. (13) Anger, rather than fear, produced the greatest overall increases in BP and was distinctly opposite from relaxation. (15) Sadness produced a distinct pattern with moderate increases in BP and vascular resistance and a decrease in cardiac output compared with changes during neutral imagery. (16) Fear, action, and joy produced similar BP changes in which systolic pressure increased and diastolic pressure was relatively unchanged. (16) A confounding factor such as a traumatic life event should also be kept in mind in case of inadequate BP control in hypertensive patients. (11)

The current study investigates confounding factors in hypertensive patients who have poor BP control.

Methods
Sample

According the data from National Household Health Survey—Prevalence of Noncommunicable Disease Risk Factors in Turkey 2017, the prevalence of hypertension in Turkey was 16.2% in 2017. (17) Sample size was calculated by using the prevalence of hypertension and the final required sample size was 207. (Z: confidence level at 95% (standard value of 1.96), P: estimated prevalence or proportions of project, e: range of confidence interval (CI))

\[ N_0 = \frac{Z^2 \times P \times (1-P)}{e^2} \]

\[(1.96)^2 \times (0.16) \times (0.84) / (0,05)^2 = 207 \text{ participants}\]

There were 200 hypertensive patients in control group who defined themselves as having regulated BP over the past six months.

Research design and setting

This study was designed as a cross-sectional study. Our sample was 407 patients with hypertension in Rize, a Northern city in the Black Sea Region of Turkey. In study group, there were 207 hypertensive patients who had admission to emergency department due to high BP. In control group, there were 200 hypertensive patients visiting family physician, who defined themselves as having regulated BP over the past six months. Only hypertensive patients receiving medicines for BP control included in the study and patients with other chronic conditions (such as psychological disorders, diabetes mellitus, hypothyroidism, hypercholesterolemia, heart disease, chronic heart failure, history of heart or cerebral attacks etc.) were excluded.

In this study, confounding factors that caused high BP in hypertensive patients were investigated. Firstly, we tried to reveal confounding factors of the patients in study group. They completed the questionnaire including sociodemographic data, lifestyle behaviors, health risks and confounding factors. The questionnaires were completed face-to-face just after their BP reduced by medicine and they calmed down. We noted their systolic and diastolic BP at the beginning of admission to emergency department. Hypertensive patients in control group also completed the questionnaire via the face-to-face interview method. Research was completed between August 2020 to December 2020. All participants gave informed written informed consent.

Data collection tool

The data collection tool used in this study included a questionnaire. We designed the questionnaire including patients’ age, gender, socioeconomic status, tobacco use, alcohol consumption, exercise, healthy diet and confounding factors. We revealed confounding factors of the patients who had admission to emergency department due to high BP. We asked them ‘Do you think there was a special reason or factor that might increase your BP?’ just after medicine (example; captopril) reduced BP and
they calmed down. Before the treatment of hypertensive patients who had admission to emergency department, we noted their systolic and diastolic BP. We also revealed confounding factors of the patients in control group.

Data analysis

Data was analyzed using the SPSS 26 statistical analysis program. Age, systolic and diastolic BP were analyzed as mean, standard deviation, minimum and maximum score. The normality of the data was examined using the Kolmogorov-Smirnov test. Descriptive statistics, including number and percentage, were used to describe sociodemographic characteristics, lifestyle behaviors, confounding factors and health risks of participants. The Regression Analysis test was used to determine the impact of confounding factors on the meansystolic and diastolic BP. The Chi-Square test was used to determine the homogeneity of study and control groups in terms of their sociodemographic characteristics, lifestyle behaviors, confounding factors and health risks. The independent samples t-test and the ANOVA test were used for analysis of independent samples. The level of significance was set as p<0.05.

Ethical approval

Formal permission was obtained from the Ethics Committee of the Faculty of Medicine of Recep Tayyip Erdogan University (Identification number: 2020/179).

Results

Sociodemographic data

Sociodemographic characteristics, lifestyle behaviors and health risks of participants are shown in Table 1. There were no significant differences between the groups in terms of their sociodemographic characteristics (p>0.05). The mean± standard deviation age of participants was 52.1 ± 13.3 in the study group and 50.5 ± 12.1 in the control group. Of the participants, 57.5% (n=119) of the study group and 54.5% (n=109) of the control group were female. About one third of the participants (32.9% of the study group and 38.0% of the control group) stated their socioeconomic status as ‘moderate’. Of the participants, 11.1% (n=23) of the study group and 9.5% (n=19) of the control group were smokers. The rate of alcohol consumption was 6.3% (n=13) of the study group and 4.5% (n=9) of the control group. Of the participants, only 3.4% (n=7) of the study group and 5.0% (n=10) of the control group were doing regular exercise more than 150 minutes per week, with 60.9% (n=126) of the study group and 65.5% (n=131) of the control group having healthy nutritional habits.

Table 1. Sociodemographic characteristics, lifestyle behaviors and health risks of participants (SG: Study Group, CG: Control Group)
| Characteristics          | SG n (%) | CG n (%) | p value |
|-------------------------|----------|----------|---------|
| Number of participants  | 207 (100)| 200 (100)|         |
| Mean age ± SD           | 52.1 ± 13.3 | 50.5 ± 12.1 | 0.340<sup>a</sup> |
| Gender                  |          |          |         |
| Male                    | 88 (42.5)| 91 (45.5)| 0.606<sup>b</sup> |
| Female                  | 119 (57.5)| 109 (54.5)|         |
| Socioeconomic status    |          |          |         |
| High                    | 28 (13.5)| 34 (17.0)| 0.108<sup>b</sup> |
| Moderate-High           | 77 (37.2)| 65 (32.5)|         |
| Moderate                | 68 (32.9)| 76 (38.0)|         |
| Tobacco use             |          |          |         |
| Yes                     | 23 (11.1)| 19 (9.5)| 0.241<sup>b</sup> |
| Alcohol consumption     |          |          |         |
| Yes                     | 13 (6.3)| 9 (4.5)| 0.169<sup>b</sup> |
| Exercise                |          |          |         |
| Yes, regular*           | 7 (3.4)| 10 (5.0)| 0.332<sup>b</sup> |
| Yes, <150 minutes       | 42 (20.3)| 47 (23.5)|         |
| Healthy diet            | 126 (60.9)| 131 (65.5)| 0.208<sup>b</sup> |

<sup>a</sup>Independent samples t-test  
<sup>b</sup>Chi-Square

Confounding factors

Confounding factors of participants are shown in Table 2. Of the hypertensive patients, 81.2% (n=168) of the study group and 34.0% (n=68) of the control group had confounding factors. There was a significant difference between the hypertensive patients of study and control group in terms of their confounding factors (p<0.001, Odds Ratio (SG/CG) value: 8.36 %95 CI: 5.30-13.17).

When we asked the patients of study group questions to reveal their confounding factors, 21.3% (n=44) stated ‘anger’, 12.6% (n=26) ‘sadness’, 11.1% (n=23) ‘anxiety’, 10.6% (n=22) ‘depressed’, 9.2% (n=19) ‘unhealthy diet’, 7.2% (n=15) ‘fatigue and poor sleep quality’, and 3.9% (n=8) ‘irregular medication’ (Table 2).

Table 2. Confounding factors of the patients with hypertension
Confounding factors and BP

Impact of confounding factors on systolic and diastolic BP in the study group is shown in Table 3. Mean systolic and diastolic BP were significantly higher in hypertensive patients having confounding factors than those without confounding factors (p=0.001, p=0.001, respectively).

Regression analysis also showed significant impact of confounding factors on mean systolic and diastolic BP in the study group (p<0.001; R²=0.164 and p<0.001; R²=0.101, respectively).

Interaction of confounding factors, systolic and diastolic BP of hypertensive patients who had confounding factors in the study group are shown in Figure 1. Hypertensives who stated their confounding factor as ‘anger’ had the highest mean systolic (191.2±10.4 mm Hg) and diastolic (110.9±7.4 mm Hg) BP. Hypertensives who stated their confounding factor as ‘sadness’ had the lowest mean systolic (155.9±10.9 mm Hg) BP, and ‘irregular medication’ had the lowest mean diastolic (104.5±9.9 mm Hg) BP, except the group of ‘others’ (97.4±4.3 mm Hg). There were significant differences between the

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| Confounding factors | SG (n=207) | CG (n=200) | p value |
|--------------------|------------|------------|---------|
|                    | n          | %          | n       | %        |
| No                 | 39         | 18.8       | 132     | 66.0     | 0.001<* |
| Yes                | 168        | 81.2       | 68      | 34.0     |

|                  | n          | %          | n       | %        |
|------------------|------------|------------|---------|----------|
| Anxiety           | 23         | 11.1       | 7       | 3.5      | 0.001<**|
| Sense of anger    | 44         | 21.3       | 17      | 8.5      |
| Sense of sadness  | 26         | 12.6       | 11      | 5.5      |
| Fatigue/poor sleep quality | 15 | 7.2 | 4 | 2.0 |
| Unhealthy diet    | 19         | 9.2        | 14      | 7.0      |
| Depressed         | 22         | 10.6       | 3       | 1.5      |
| Irregular medication | 8   | 3.9        | 4       | 2.0      |
| Others            | 11         | 5.3        | 8       | 4.0      |

* Pearson Chi-Square **Chi-Square

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Table 3. Impact of confounding factors on systolic and diastolic BP in the SG (n=207)

| Confounding factors (n=207) | Mean Systolic BP (mm Hg) | p value | Mean Diastolic BP (mm Hg) | p value |
|-----------------------------|--------------------------|---------|--------------------------|---------|
|                             | SD*                      | Min-max | SD*                      | Min-max |
| No (n=39)                   | 162.1                    | 9.9     | 145-205                  | 0.001** |
| Yes (n=168)                 | 174.5                    | 15.5    | 142-220                  | 102.1   | 7.9  | 91-113 | 0.001** |

* Standard deviation ** Independent samples t-test
groups in terms of their mean systolic and diastolic BP ($F_{(7, 160)} = 31.99; p<0.001$, $F_{(7, 160)} = 4.83; p<0.001$, respectively). Mean systolic BP of hypertensives who stated their confounding factor as ‘anger’ was significantly higher than those the remaining groups. Mean systolic BP of hypertensives who stated their confounding factor as ‘sadness’ was significantly lower than those the remaining groups ($p<0.001$, Post Hoc Test, Tukey).

Discussion

In this study, the effect of confounding factors on BP in hypertensives with high BP was investigated by comparing those in hypertensives with regulated BP. More than three quarter of the hypertensive patients who had admission to emergency department due to high BP had confounding factors. In the control group, about one-third of hypertensives with regulated BP had confounding factors. There was a significant difference between the hypertensives of study and control groups in terms of their confounding factors. So, this study suggested that confounding factors impair BP control in patients with hypertension. A confounding factor should be kept in mind in case of poor BP control in hypertensive patients. (7, 8, 11-15)

Mean systolic and diastolic BP were significantly higher in hypertensives having confounding factors than those without confounding factors in the study group. Furthermore, each confounding factor had significantly different effect on BP in hypertensives having confounding factors in the study group. In a study which investigated the influence of happiness, anger, and anxiety on the blood pressure of borderline hypertensives; happiness, anger, and anxiety increase BP to differing degrees. (13) Mean systolic BP of hypertensives who stated their confounding factor as ‘anger’ was significantly higher, and ‘sadness’ was significantly lower than those the remaining groups. Our finding was consistent with literature. The comparison of the pressures during each reported emotional state show that anger increase BP more than happiness. (13) In a study which investigated cardiovascular differentiation of happiness, sadness, anger, and fear, it was shown that anger, rather than fear, produced the greatest overall increases in BP. (15) In a research which investigated cardiovascular differentiation of emotions showed that sadness produced a distinct pattern with moderate increases in BP. (16)

We found that anxiety, anger, sadness, fatigue, poor sleep quality, unhealthy diet, depressed, and irregular medication seem to be confounding factors for elevated BP. In addition, mentioned as ‘others’ in this study, happiness, feeling tense, panic, sense of worthlessness, and sense of cheerless also were confounding factors for elevated BP.

In this study, anxiety was a confounding factor for elevated BP. Our finding was consistent with literature. Anxiety can activate the sympathetic nervous system, increase cardiac output, constrict blood vessels, and raise arterial BP. (18) First, anxiety increases BP in the short term, and the white coat effect derived from anxiety is a typical example. (19, 20) In a study which investigated association between anxiety and hypertension has shown that there was an association between anxiety and increased risk of hypertension. (21) It has been reported that patients with hypertension on antidepressant medications
have lower BPs compared to those not on these medications possibly due to decreased baroreflex sensitivity and altered neuro-endocrine pathways. (22, 23)

In this study, about one-tenth of hypertensives in the study group were depressed. Depression is common in patients with uncontrolled hypertension and may interfere with BP control. In a study about hypertension, depression was a risk factor for poor BP control in hypertensive patients. (24) In another study about hypertension, it was shown that despite antihypertensive treatment, mean systolic and diastolic BP in patients with moderate/severe depression was significantly higher, than in group of patients without depression. (25)

In this study, we revealed ‘fatigue’ as confounding factor for elevated BP. On the contrary, in a research which investigated the relationship between fatigue and cardiac functioning, fatigue was not associated with BP at rest and no significant differences were found in heart rate or BP response between the various fatigue groups. (26)

In this study, poor sleep quality was a confounding factor for elevated BP and our finding was consistent with literature. Obstructive sleep apnea is common in patients with resistant hypertension, which is defined as BP that remains uncontrolled with three or more medications. (27) Insomnia with objective short sleep duration also is associated with increased hypertension risk. (27) Periodic limb movements in sleep increases BP, especially when associated with arousals. (27)

It was important to find that, especially after diet high in sodium, about one-tenth of hypertensives in the study group had admission to emergency department due to high BP. Adding salt into meals was significantly and independently associated with poor BP control. (8) Higher BP was associated with higher alcohol consumption, diet high in sugar-sweetened beverages and diet high in sodium. (9) Adherence to the Mediterranean diet pattern can be correlated with BP control. (28) Sodium reduction resulted in a significant decrease in BP of 3.5% in patients with hypertension. (29)

**Conclusion**

This study has shown that confounding factors impair BP control in patients with hypertension. Confounding factors should be kept in mind and revealed in case of poor BP control in hypertensive patients. This study has also shown that systolic and diastolic BP were significantly higher in hypertensives having confounding factors than those without confounding factors. Furthermore, each confounding factor had significantly different effect on BP in hypertensives.

**Limitations**

Confounding factors were revealed based on patient's self-assessment. However, as we know, there is not a scale to reveal confounding factors yet, which Turkish validity and reliability study was performed.

**Declarations**
Ethical approval

Formal permission was obtained from the Ethics Committee of the Faculty of Medicine of Recep Tayyip Erdogan University (Identification number: 2020/179).

Funding:

None

Competing interests: None

Acknowledgement: None

Conflict of Interest: None

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**Figures**

**Figure 1**

Interaction of confounding factors, systolic and diastolic BP of hypertensives having confounding factors in the SG (n=168)