doi: 10.53446/actamednicomedia.1416055

Acta Medica Nicomedia

Cilt: 7 Sayı: 2 Haziran 2024 / Vol: 7 Issue: 2 June 2024
https://dergipark.org.tr/tr/pub/actamednicomedia

Research Article | Araştırma Makalesi

IS ONLY RESTING BLOOD PRESSURE MONITORING SUFFICIENT IN OBESE HYPERTENSIVE INDIVIDUALS?

OBEZ HİPERTANSİF HASTALARDA SADECE İSTİRAHAT KAN BASINCI İLE TAKİP YETERLİ Mİ?

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ABSTRACT

Objective: Both intraday blood pressure changes and blood pressure response to exercise differ in obese and non-obese individuals. Blood pressure changes in exercise pose an increased risk for cardiovascular events independent of resting blood pressure. In this study, we evaluated the effect of exercise on blood pressure variability in obese and non-obese hypertensive (HT) individuals whose resting blood pressures were within normal ranges with medical treatment.

Methods: This retrospective study included 30 obese and non-obese (total 60) patients, each undergoing 24-hour ambulatory blood pressure monitoring (24h ABPM) and Bruce protocol exercise testing. All patients' mean resting blood pressures at 24h ABPM were within the normal range. The two groups' blood pressure changes in the exertion test were compared.

Results: Systolic and diastolic blood pressure increases were higher in obese than in non-obese at all three levels of the exercise test. Although it varies according to the stages of the exercise test, the increase in systolic blood pressure in obese was 1.3-2 times that of non-obese, and the increase in diastolic blood pressure was 2-2.5 times. When the factors associated with the blood pressure changes in the patients' exertion test were investigated, the BMI was correlated with the blood pressure changes in all 3 stages of the exercise test.

Conclusion: It seems that evaluation with resting blood pressure alone is insufficient in the follow-up of obese HT patients. Therefore, treatment strategies aimed at weight loss in patients should be an absolute and continuous part of blood pressure control with antihypertensives. In addition, exercise programs such as antihypertensive treatments should be determined individually for these patients.

Keywords: Hypertension, obesity, blood pressure change in exercise, 24-hour ambulatory blood pressure monitoring

ÖZ

Amaç: Obez bireylerde gün içi ve egzersize cevap olarak oluşan kan basıncı değişkenliği obez olmayan bireylere göre farklılık göstermektedir. Egzersiz sırasındaki kan basıncı değişiklikleri, istirahat kan basıncından bağımsız olarak kardiyovasküler olaylar açısından artmış risk oluşturur. Bu çalışmada, medikal tedavi ile istirahat kan basıncı normal aralıklarda olan obez ve obez olmayan hipertansif (HT) bireylerde egzersizin kan basıncı değişkenliği üzerine etkisini değerlendirdik.

Yöntem: Bu retrospektif çalışmaya, her biri 24 saatlik ambulatuvar kan basıncı takibi (24s AKBM) ve Bruce protokolünde egzersiz testine tabi tutulan 60 hasta (30 obez ve 30 obez olmayan) dahil edildi. Tüm hastaların 24 saatlik AKBM'deki ortalama istirahat kan basınçları normal aralıktaydı. İki grubun efor testindeki kan basıncı değişiklikleri karşılaştırıldı.

Bulgular: Egzersiz testinin her üç düzeyinde de sistolik ve diyastolik kan basıncı artışları obezlerde obez olmayanlara göre daha yüksekti. Egzersiz testinin aşamalarına göre değişmekle birlikte obezlerde sistolik kan basıncındaki artış obez olmayanlara göre 1,3-2 kat, diyastolik kan basıncındaki artış ise 2-2,5 kattı. Hastaların efor testindeki kan basıncı değişiklikleriyle ilişkili faktörler incelendiğinde, VKİ'nin egzersiz testinin her 3 aşamasında da kan basıncı değişiklikleriyle korele olduğu görüldü.

Sonuç: Obez HT hastalarının takibinde tek başına istirahat kan basıncı ile değerlendirmenin yetersiz olduğu görülmektedir. Bu nedenle hastalarda kilo kaybına yönelik tedavi stratejileri, antihipertansiflerle kan basıncı kontrolünün mutlak ve sürekli bir parçası olmalıdır. Ayrıca antihipertansif tedaviler gibi egzersiz programları da bu hastalarda bireyselleştirilmelidir.

Anahtar Kelimeler: Hipertansiyon, obezite, egzersiz kan basıncı değişkenliği, 24-saat ambulatuvar kan basıncı monitoziasyonu

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Submitted/Başvuru: 08.01.2024 • **Accepted/Kabul:** 18.06.2024 • **Published Online/Online Yayın:** 30.06.2024

Introduction

The prevalence of hypertension (HT) is approximately 25-30% and is a significant risk factor for cardiovascular diseases (CVD).[1] HT is the most common modifiable risk factor for death related to CVD.[2] Controlling blood pressure reduces CVD-related and all-cause mortality, and this positive effect is correlated with blood pressure reduction.[3] HT is strongly and positively linked with visceral and ectopic fat.[2]

Obesity is defined as a body mass index (BMI) over 30 kg/m^2 and its prevalence is estimated to be approximately 15-20% worldwide.[4] Obesity causes increases in blood pressure due to structural or functional changes in arterial/arteriolar vascular area resulting from increased sympathetic activation, tubular sodium reabsorption, RAS activation and sympathetic activity, and deterioration in endothelial function and baroreceptor activity.[5] The prevalence of HT in non-obese individuals is was 15%; in obese women and men, it is 38% and 42%, respectively.[6] The risk of developing HT increases by 2.2 to 2.6 times in obese individuals.[7] In the treatment of HT in obese patients, it is recommended to lose weight by increasing physical activity in addition to drug therapy.[8]

Moderate increases in blood pressure are expected during physical activity.[11] Studies show that individuals with higher blood pressure increases during exercise have higher cardiovascular-related mortality and morbidity, regardless of higher resting blood pressure averages.[10-12] An exaggerated blood pressure response during an acute exercise bout is defined as an increase in systolic or diastolic blood pressure of >10 mmHg per metabolic equivalent at any workload and is considered an indicator of increased cardiovascular risk.[13] Evidence suggests that the arterial pressure response to exercise is exacerbated in obese individuals compared with normal-weight adults.[13]

This study aimed to investigate the effect of obesity on blood pressure variability during exercise in patients diagnosed with HT, all of which were regulated by medical treatment.

Methods

This is a retrospective study, and it was approved by Konya Necmettin Erbakan University's ethics committee with the number 2020-2798. The study included 60 patients, 30 obese and 30 non-obese, who underwent 24-hour ambulatory blood pressure monitoring (ABPM) and exercise stress tests between 01.01.2019 and 30.06.2020.

The inclusion and exclusion criteria were as follows. Inclusion criteria; 1) Between 30-60 years old, 2) Diagnosed with HT, 3) Having 24-h ABPM and exercise test (in Bruce protocol), 4) Average of 24h ABPM measurements below 130/80 mmHg. Exclusion criteria: 1) Not between 30-60 years of age, 2) BMI >35 kg/m^2 (as there will be a restriction in effort capacity and compliance with the test will not be complete), 3) Patients with anemia, 4) Patients with heart failure, 5) Patients with chronic kidney failure, 6) Patients with hyperthyroidism or hypothyroidism, 7) patients with uncontrolled diabetes, 8) Using beta blockers, 9) History of an acute coronary syndrome in the last six months, 10) Not using medical therapy for blood pressure control or using more than two antihypertensive drugs.

The patients' personal and medical information was scanned from the hospital system.Concomitant disease information, height, weight, age, gender, drug status, serum urea, creatinine, sodium, potassium, fasting glucose, serum alanine aminotransferase, albumin, and hemoglobin values were recorded.

Patients were divided into two groups: obese with a BMI between 30 and 35 kg/m^2 and non-obese with a BMI below 30 kg/m^2. There were 30 patients in each group. Those with more than a 10% difference in nighttime blood pressure reduction compared to the mean daytime blood pressure were considered dippers, and those with less than a 10% difference were considered non-dippers. The blood pressure data of all patients before the exercise test, at all stages of the exercise test, and at 24h ABPM were evaluated. The blood pressure values of the patients subjected to equivalent exercise by applying the Bruce protocol on the treadmill were recorded as systole-1, diastole-1, etc., at each stage of the effort test. The difference between these values with resting was recorded as Δsystol-1, Δdiastole-1, etc.

Exercise Test

The standard Bruce protocol for the Exercise Test was applied to all patients, and the "GE-T2100" device was used. This protocol is a graded continuous test for maximal effort on a cycle ergometer or a treadmill. The workload at the beginning of the test is 25 W, and it increases with 25 W every 2 minutes up to the maximal voluntary capacity or until ventricular arrhythmias such as ventricular tachycardia or ventricular fibrillation occur. Continuous ECG and blood pressure measurements are obtained during the test.[14] To compare our findings with the blood pressure values obtained from the bicycle ergometer test, used as an effort test in different studies, the matching table recommended in the 8th edition of the Exercise Test and Instruction Manual of ACSM was used.[15]

24-Hour Ambulatory Blood Pressure Monitoring

"Mobile Graph New Generation 24H ABPM Classic" was used for 24-h ABPM. Standard deviations of 24-hour ambulatory blood pressure measurements were used to compare blood pressure variability. This value was specified as SD_{24}.

Statistical Analysis

All statistics were done with SPSS 20 program. Kolmogorov Smirnov, Shapiro-Wilk, and skewness-kurtosis analyses were performed for the normal distribution. Parametric tests were applied to the variables found to be normally distributed by the kurtosis-skewness analysis. Parameters without normal distribution were evaluated with nonparametric tests. The means and standard deviations of the data were calculated. Pearson and Spearman correlation analysis was performed for numerical variables. Student T-test and Mann-Whitney U test were used for the effect of obesity and gender difference. The chi-square test was used to compare the categorical variables between the obese and nonobese groups. The data were evaluated with a confidence interval of 95% and a p<0.05 as significant.

Results

A total of 60 patients, 19 female and 41 male, were included in the study. The mean age of all patients was 50.2±7.3, and the mean BMI was 29.8±4 kg/m2. The patients were divided into two groups: obese and non-obese. There were 30 patients in each group. Demographic characteristics of the two groups, laboratory values, and results of 24h ABPM are given in Table 1. There was no difference between the two groups in both 24-h ABPM measurements and resting blood pressures at the beginning of the exercise test.

Table 1. Clinicopathological features of patients with CRC (n=50)

	Non-Obese Patients (n=30)	Obese Patients (n=30)	p Value
Age (years)	48.3±7.2	52.2±7	0.056
Gender (Male/Female)	21/9	20/10	0.781
BMI (kg/m²)	26.3±2	33.5±1.38	**0.001**
Patients with Diabetes Mellitus	5	6	0.739
Urea (mg/dl)	31.8±15.3	27.5±5.6	0.392
Creatinine (mg/dl)	1±0.5	0.9±0.3	0.829
SGPT (U/L)	22±9.4	19.9±6	0.588
Sodium (mmol/L)	139.8±1.9	139±1.9	0.185
Potasium (mmol/L)	4.4±0.4	4.4±0.3	0.722
Blood Glucose (mg/dl)	120.2±56.2	121.5±46.2	0.880
Hemoglobin (g/dl)	15.3±1.6	15.1±1.2	0.372
Albumin (g/dl)	4.4±0.4	4.3±0.4	0.405
Resting Systolic BP (mm/Hg)	129.3±9	129.6±8.4	0.882
Resting Diastolic BP (mm/Hg)	84.7±11.8	79.8±7.7	0.061
24h ABPM Systolic (mm/Hg)	119±8.9	119.5±8.2	0.811
24h ABPM Diastolic (mm/Hg)	72.4±6.5	73±6.4	0.795

BMI: Body mass index, SGPT: Serum glutamate pyruvate transaminas, BP: Blood Pressure, ABPM: Ambulatory blood pressure monitoring

In the study, exercise testing was performed on all patients using the Bruce protocol. When the change of blood pressure in all three stages of the exercise test was examined according to the initial blood pressures, the increases in systolic and diastolic blood pressure in all three stages of the exercise test were higher in obese individuals than in non-obese individuals (Table-2).

When the factors related to the blood pressure changes of the patients in the exercise test were investigated, BMI was found to be correlated with both the resting blood pressure and the blood pressure changes in all three stages of the exercise test (Figure 2).

Except for obese and non-obese patients, they were divided into two subgroups, dipper and non-dipper, according to the difference in blood pressure changes between day and night. The number of dippers and non-dipper patients was 10 and 20 in the obese group, respectively, and 8 and 22 in the non-obese group, and there was no significant difference between the two groups(p=0.573).

Discussion

In our study investigating the role of obesity in blood pressure changes during exercise in patients with regulated HT, we reached two significantresults. First, while there was no difference between obese and non-obese individuals regardingintraday blood pressure changes at 24-h ABPM, there was a substantialincrease in systolic and diastolic blood pressure in obese subjects during exercise. According to the exercise test levels, the increase in systolic blood pressure in obese individuals was 1.3-2 times that of non-obese individuals, and the increase in diastolic blood pressure was 2-2.5 times. Second, we found that BMI correlated with increased blood pressure during exercise.

Table 2. Blood pressure variability in all three stages of the exercise test

Parameters	Average		Average Difference (Obese vs Non-obese)	95% Confidence Interval		p Value
	Non-Obese Patients (n=30)	Obese Patients (n=30)				
Systolic-1	150.4±22	162.9±16.5	**12.6**	**2.5**	**22.6**	**0.015**
Diastolic-1	92.3±10.6	92.4±10.6	0.1	-5.4	5.6	0.971
ΔSystolic-1	19.9±15.3	34.9±15.5	**14.9**	**7**	**22.9**	**0.000**
ΔDiastolic-1	7.3±10.4	13±10.6	**5.7**	**3.1**	**9.8**	**0.015**
Systolic-2	160±21.3	171.2±17.4	**11.2**	**1.2**	**21.2**	**0.03**
Diastolic-2	95.2±11.9	96.5±11.3	1.4	-4.6	7.4	0.649
ΔSystolic-2	30±14.7	43.3±15.2	**13.3**	**5.6**	**21**	**0.001**
ΔDiastolic-2	10.7±11.9	17.3±11.8	**6.6**	**0.45**	**12.7**	**0.036**
Systolic-3	167.1±21.7	178.8±15.1	**11.7**	**2.02**	**21.4**	**0.019**
Diastolic-3	94±11.1	98.5±11.4	4.6	-1.2	10.4	0.12
ΔSystolic-3	37.2±17.6	49.2±12	**12**	**4.2**	**19.8**	**0.003**
ΔDiastolic-3	11.5±12	18.6±9.6	**7**	**1.4**	**12.7**	**0.015**

ΔSystolic-1=1. Stage systolic blood pressure – Resting systolic blood pressure
ΔDiastolic-1=1. Stage diastolic blood pressure – Resting diastolic blood pressure
ΔSystolic-2=2. Stage systolic blood pressure – Resting systolic blood pressure
ΔDiastolic-2=2. Stage diastolic blood pressure – Resting diastolic blood pressure
ΔSystolic-3=3. Stage systolic blood pressure – Resting systolic blood pressure
ΔDiastolic-3=3. Stage diastolic blood pressure – Resting diastolic blood pressure

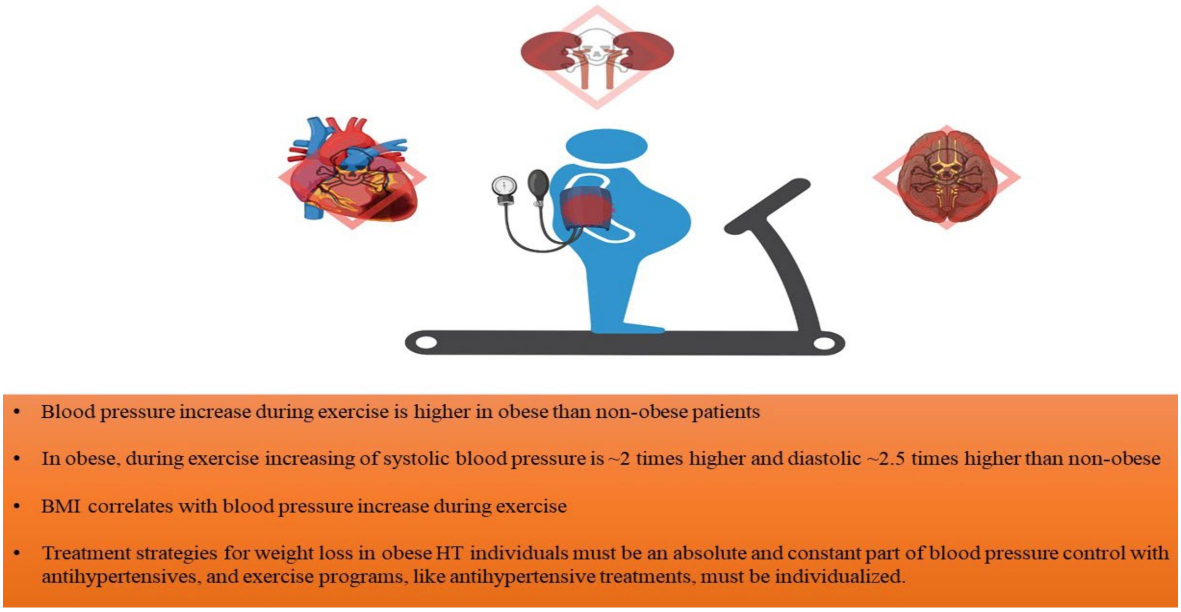

Figure 1. Study Brief

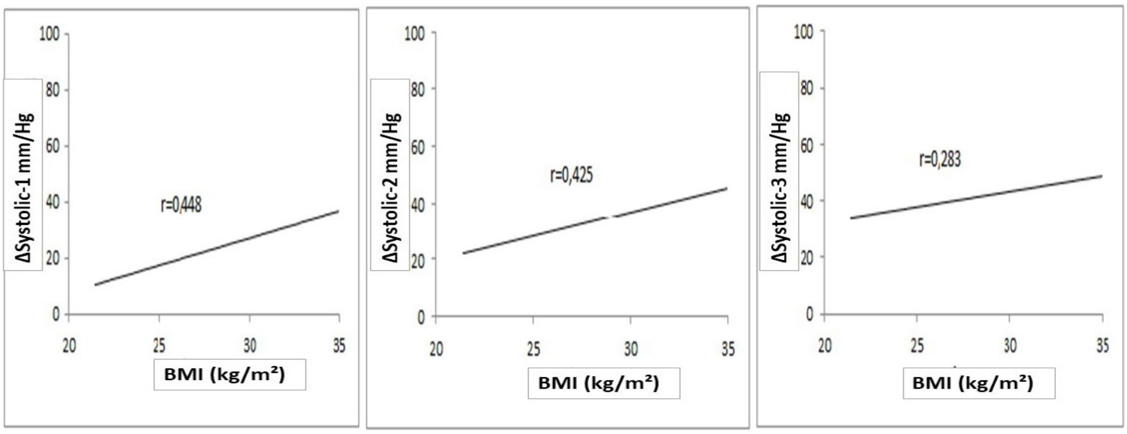

Figure 2. Correlation of exercise blood pressure variability with BMI

Physicians recommend that obese patients exercise frequently to provide more accessible and more successful blood pressure regulation and to promote weight loss. However, personalizing these exercises is unfortunately not part of daily practice. As is known, blood pressure rises during physical activity. Studies have shown that high resting blood pressure and high blood pressure variability, especially systolic blood pressure, in daily life or during physical activity are also associated with increased cardiovascular risk. The risk of death due to cerebral, renal, and cardiovascular causes increases in these patients.[16,17]

There is an increased propensity for both HT and cardiovascular events in obesity. Evidence indicates that intraday blood pressure variability is more remarkable in obese individuals than in non-obese subjects.[18] Our study showed no significant difference in intraday blood pressure variability between the two groups. We think this is because our patient group comprises patients who successfully regulate blood pressure with medical treatment. This is due to their sedentary lifestyle with limited physical activity. High resting blood pressure is among the important risk factors for blood pressure increases in response to exercise. Individuals with high resting blood pressure are expected to have higher blood pressure elevations during exercise.[18] All the patients in our study were patients with regulated HT and did not use β-blocker group drugs that block the sympathetic nervous system. Therefore, it may be possible to attribute the difference in blood pressure changes during exercise between the two groups to metabolic events brought about by obesity.

We found that the increase in blood pressure during exercise was 1.5-2 times higher in obese patients than non-obese patients. Numerous studies have shown increased blood pressure during exercise in HT patients.[19-21] Our study is valuable because it investigates changes in obese and non-obese patients whose blood pressure regulation is ensured and resting blood pressure is in the normal range.The number of studies examining the effect of obesity on exercise blood pressure variability is limited.[22-24] Filipovski et al. evaluated BMI and exercise blood pressure variability in a subgroup analysis of their studies and found a difference between blood pressure variability as BMI increased. Still, there was no comparison between obese and non-obese individuals.[23] Thanassoulis et al. have shown that every 4.6 kg/m^2 increase in BMI causes a 3.3 mm/Hg increase in exercise systolic pressure.[24] Our study supports the literature, and the increase in systolic and diastolic blood pressure at all stages of the exercise test was correlated with BMI.

Increased sympathetic and RAS activation, impaired endothelial function, and baroreceptor activity in obese individuals predispose to increased blood pressure during exercise. In addition, structural and functional deteriorations in the arterial and arteriolar vascular areas contribute to the difficulty of hypertension regulation and the development of complications secondary to HT in these patients.[5,26,27] Perivascular adiposity and increased inflammatory adipokine activity in obese individuals predispose to vascular inflammation and endothelial dysfunction.[26,27] In addition, increased vascular inflammation and subsequent vascular stiffness impair the activity and bioavailability of NO, causing increased endothelin-1 up-regulation in the vascular pathway. As a result, blood pressure regulation becomes more complex in obese individuals, especially when sympathetic activity and vascular contraction increase.

In the follow-up of HT patients, resting blood pressure measurements are generally taken as a basis. However, our study and other studies have shown no clear relationship between resting blood pressure and BMI.[28] There are no definitive recommendations on blood pressure variability in the hypertension guidelines, and the physiological limits of blood pressure variability are not clearly defined.[29] However, due to the relationship between blood pressure variability and mortality and end-organ damage, there are recommendations such as choosing antihypertensives that reduce blood pressure variability in the treatment of hypertension, administering drugs in divided doses, or using combined treatments[30]. It is incomplete to evaluate HT patients with resting blood pressures only and to ignore that these patients have more blood pressure changes during exercise than non-obese individuals, thus facing an increased risk of cardiovascular events. For this reason, treatment strategies for weight loss in obese individuals must be an absolute and constant part of blood pressure control with antihypertensives, and exercise programs must be individualized. More extensive studies are needed to determine the physiological limits of increased blood pressure during exercise testing and the need for additional treatment in individuals with increased exercise blood pressure. Unfortunately, when obesity-related complications are mentioned, we mean only "unable to regulate resting blood pressure." Our study showed that blood pressure response to exercise was much higher in these patients than in non-obese individuals. In this patient group, blood pressure response to exercise may be considered when evaluating complications for surgical indications in treating obesity. The study's inadequacy of the variables that may affect blood pressure changes, such as smoking or hyperlipidemia, and the low number of patients are significant limitations.

Summary

- While resting blood pressure and intraday blood pressure changes in 24-h ABPM are similar in obese and non-obese patients, blood pressure increase during exercise may be higher in obese.
- According to the stages of the exercise test, the increase in systolic blood pressure in obese individuals was 1.3-2 times that of non-obese individuals and 2-2.5 times in diastolic, and BMI correlates with blood pressure increase during exercise.
- It is not sufficient to evaluate only resting blood pressure in the follow-up of HT patients.

Acknowledgement
We would like to thank all patients and healthy study participants.

Compliance with Ethical Standards
The ethics committee of Konya Necmettin Erbakan University approved this study with the number 2020-2798.

Conflict of Interest
The authors declare no conflicts of interest.

Author Contribution
MEE, HZT and MAD: Study idea, hypothesis, study design; MEE, HO, YO and IB: Material preparation, data collection and analysis; HO and IB: Writing the first draft of the article; HZT and MAD: Critical review of the article finalization and publication process.

Financial Disclosure
None

Data Availability Statement
If requested, the data can be shared with the readers.

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