

## ORIGINAL ARTICLE

# EVALUATION OF THE ANTIHYPERTENSIVE EFFECT OF THE THYME AMONG PATIENTS SUFFERING FROM HYPERTENSION IN IRAQ

DOI: 10.36740/WLek202312110

**Qayssar Joudah Fadheel<sup>1</sup>, Rusul Ahmed Mohammed<sup>2</sup>**<sup>1</sup>DEPARTMENT OF PHARMACOLOGY AND TOXICOLOGY, COLLEGE OF PHARMACY, UNIVERSITY OF BABYLON, IRAQ<sup>2</sup>DEPARTMENT OF PHARMACOLOGY AND TOXICOLOGY, COLLEGE OF PHARMACY, AL MUSTAQBAL UNIVERSITY, IRAQ**ABSTRACT**

**The aim:** of research is to test effectiveness of thyme on patients with high blood pressure and comparing between blood pressure of patients who took thyme and patients who did not among different ages.

**Materials and methods:** This study concerning patients with high blood pressure, (3/2022 to 3/2023). Collecting data was depend on interviewed patients directly to get information. A questionnaire paper includes several questions. Interview included convincing patients to take thyme for 15 days to know how could thyme effect on their blood pressure and over different patients.

**Results:** A significant difference in distribution between male and female within control and treated groups. A significant difference between all age groups when compared control and treated group, and decrease in systolic blood pressure when patients taking own drug plus thyme compared with patients taking own drug alone, but non-significant decrease in systolic blood pressure when compared with control group, a non-significant decrease in systolic blood pressure in patients taking own drug when compared with control group. A significant decrease in diastolic blood pressure when patients taking own drug plus thyme in comparison with patients taking own drug alone, but non-significant reduction in diastolic blood pressure when compared with group which considered control, non-significant decrease in diastolic blood pressure in patients taking own drug when compared with control group.

**Conclusions:** Thyme herbs induce normalization hypertension and keeps blood pressure in usual range. The available clinical trial data provide evidence for the safe utilization of herbal preparations containing Thyme in the treatment of hypertension.

**KEY WORDS:** hypertension, thyme, carvacrol, rosmarinic, herb

Wiad Lek. 2023;76(12):2614-2624

**INTRODUCTION**

Hypertension is characterized by the presence of consistently elevated blood pressure in the systemic arteries. Blood pressure (BP) is frequently quantified as the ratio between systolic pressure and diastolic blood pressure (the pressure during relaxation of the heart). The term hypertension, referred to a systolic blood pressure (SBP) greater than 140 mmHg or a diastolic blood pressure (DBP) greater than 90 mmHg, is a significant and escalating health concern on a global scale [1]. Cardiovascular disease is highly prevalent among individuals aged 60 years or older, with nearly two-thirds of this population being affected by this condition [2]. According to estimates, uncontrolled hypertension is attributed to approximately 7.5 million global fatalities annually [3]. In the United States, this condition alone incurs health-care expenditures, medication costs, and productivity losses amounting to over 47 billion dollars [4, 5].

The term "essential hypertension" is used to describe the condition in approximately 95% of hypertensive patients, where elevated blood pressure is a consequence of intricate interactions between various environmental and genetic factors. Conversely, about 5% of patients experience hypertension due to identifiable specific causes, referred to as secondary hypertension [6]. Lifestyle modifications for hypertension encompass various strategies, such as weight reduction for patients who are obese or overweight, embracing the Dietary Approaches to Stop Hypertension (DASH) eating plan, limiting dietary sodium intake to an ideal target of 1.5 grams per day (equivalent to 3.8 grams of sodium chloride), engaging in regular aerobic physical activity, practicing moderation in alcohol consumption (limiting intake to two or fewer drinks per day), and discontinuing smoking. For the majority of patients with prehypertension, lifestyle modification is considered to



**Fig. 1.** Thyme plant.

be an adequate approach. However, for hypertensive patients who also have further cardiovascular risk factors or damage to the target organ, lifestyle changes alone are not enough [7]. Several studies have demonstrated that thyme exhibits a positive impact on the reduction of blood pressure. The selection of an initial drug is obtained by blood pressure level elevation and the available of compelling indications for specific medications. The selection of pharmaceutical agents for the treatment of hypertension (HTN) is influenced by several factors, including but not restricted to age, presence of comorbidities, ethnicity, and pregnancy status. The primary medication classes consist of calcium channel blockers (CCBs), angiotensin-converting enzyme (ACE) inhibitors, angiotensin II receptor blockers (ARBs), and thiazide diuretics, which have been identified as appropriate first-line treatment choices [8].

## THYME

Thyme, a fragrant perennial evergreen herb, is classified under the genus *Thymus* within the *Lamiaceae* family (Fig. 1). It is characterized by its production of petite flowers that can range in color from white to lilac or pink. The existence of more than 350 thyme species can be attributed primarily to their high propensity for hybridization. Thyme is widely recognized for its abundant array of therapeutic advantages. Thyme has been historically utilized for its therapeutic properties, with its leaves, flowers, and oil being employed in the treatment of diverse diseases and ailments. Thyme possesses both

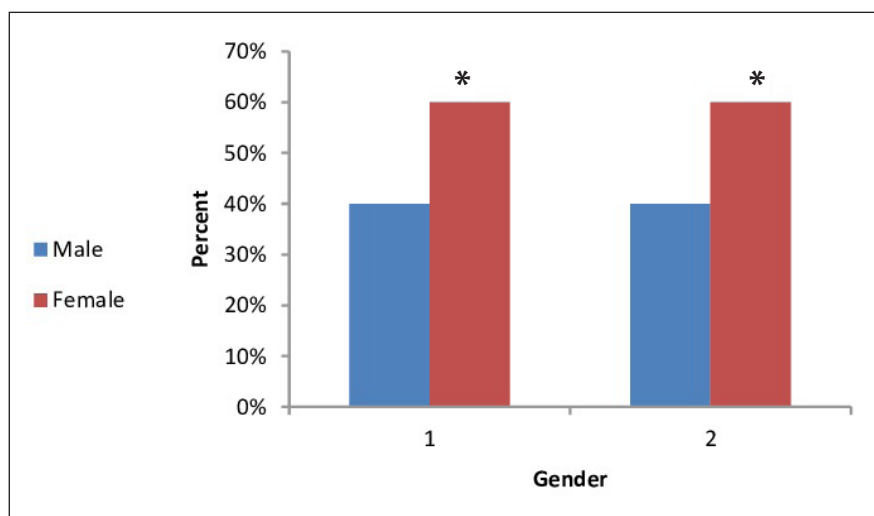
antiseptic and antimicrobial properties, rendering it a highly efficacious remedy for treating colds, coughs, and various respiratory ailments. Thyme is known to exhibit antibacterial properties, making it a common ingredient in facial cleansers and anti-acne creams. Thyme possesses a bioactive compound that exhibits potential in reducing blood pressure levels. Thyme, akin to other herbal remedies, exhibits a limited number of adverse effects. Thyme possesses bioactive constituents, namely thymol and carvacrol, which have the potential to induce irritation of the mucous membranes in individuals exhibiting sensitivity. There is a lack of established empirical evidence regarding the safety of this herb for pregnant and breastfeeding women, as well as a dearth of contraindications. Nevertheless, due to thyme's historical use as a traditional method to stimulate menstruation, there exists a potential risk of miscarriage for pregnant women [9].

## THE AIM

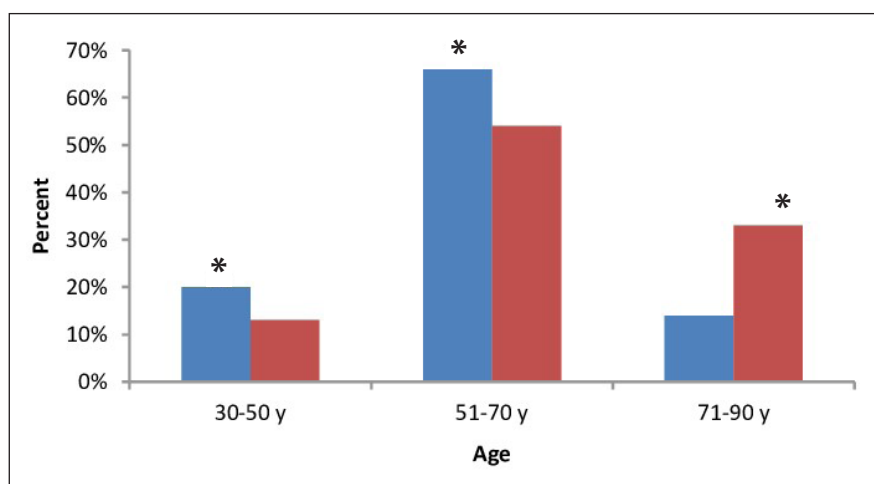
The aim of this research is to test effectiveness of thyme on patients with high blood pressure and comparing between blood pressure of patients who took thyme and patients who did not among different ages.

## MATERIALS AND METHODS

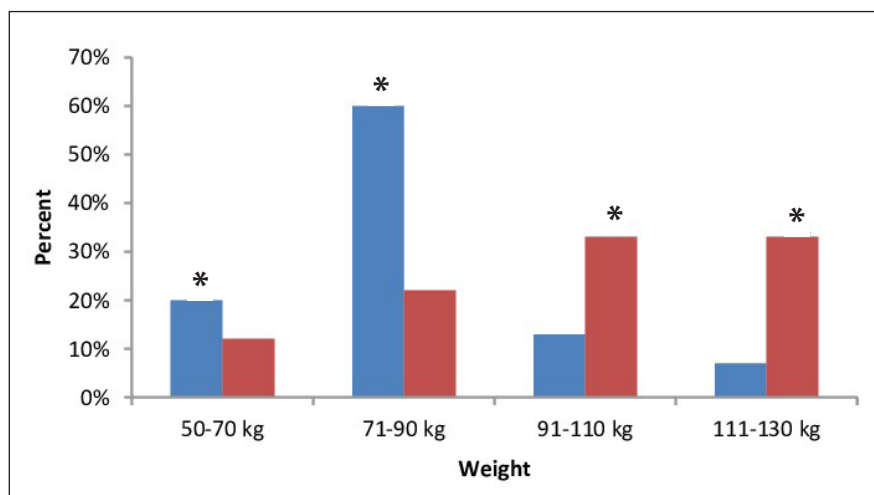
This study concerned patients with high blood pressure, and it was conducted during the period from November 2022 to March 2023, during which



**Fig. 2.** Gender distribution among study population (\* - significant difference).



**Fig. 3.** Age distribution among study population (\* - significant difference).



**Fig. 4.** Weight distribution among study population (\* - significant difference).

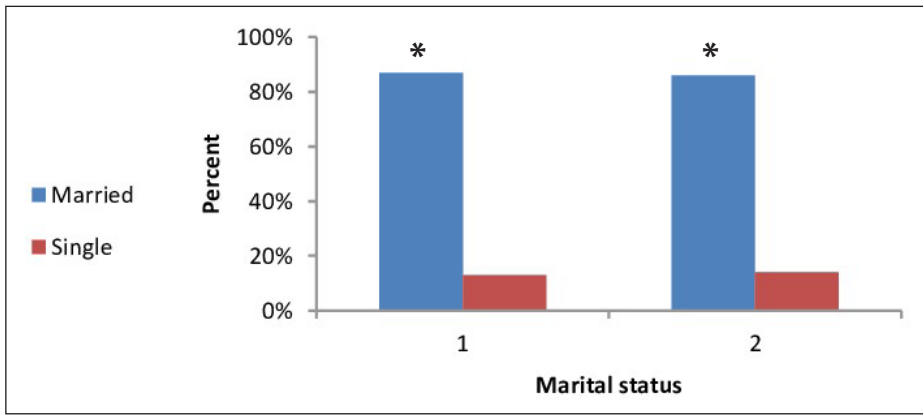
we did a field research over people with high blood pressure that we know, and who include people from our family and friends, and also people we have a relationship with them , so there was no need to go To the Hospital to look for patients, because we had to follow up the patients closely and measure the extent of their blood pressure changes to obtain the better result.

**INCLUSION CRITERIA**

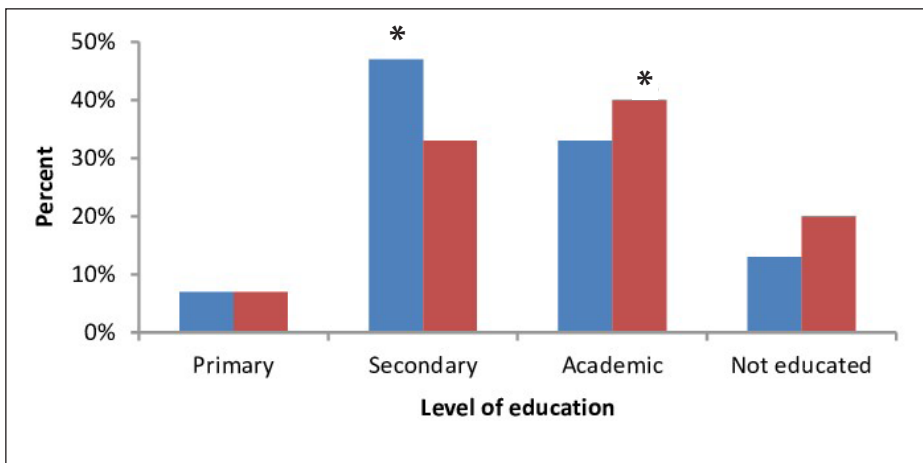
Included patients with high blood pressure who controlled this high by taking various antihypertensive drugs.

**EXCLUSION CRITERIA**

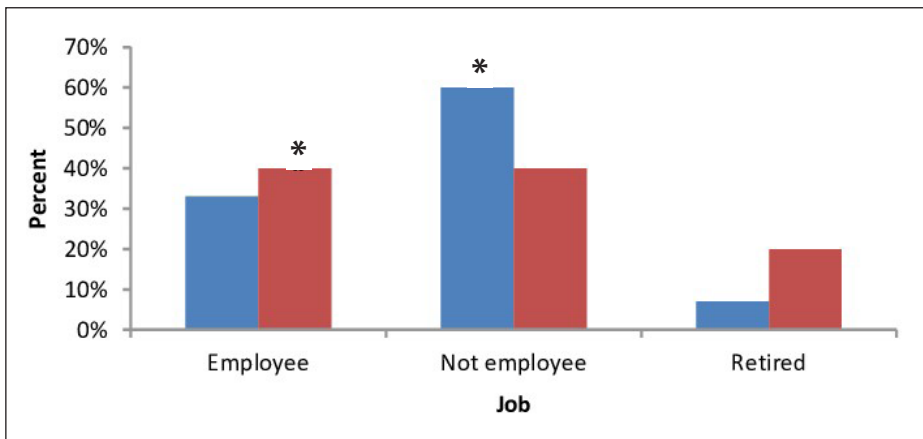
Patients who have high blood pressure and do not take any medication to control it and control



**Fig. 5.** Distribution of marital status among study population (\* - significant difference).



**Fig. 6.** Distribution of level of education among study population (\* - significant difference).



**Fig. 7.** Distribution of job among study population (\* - significant difference).

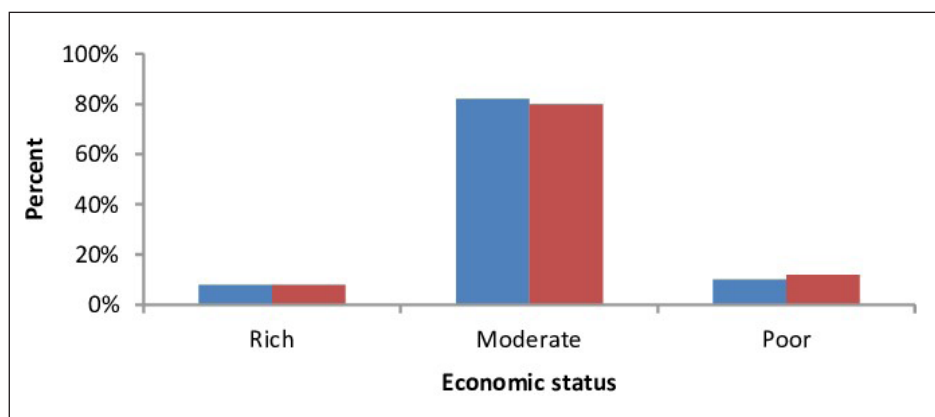
it through diet and physical activity only, patients who did not complete the treatment and did not keep in touch with us, and patients who refused to take thyme.

### SAMPLING

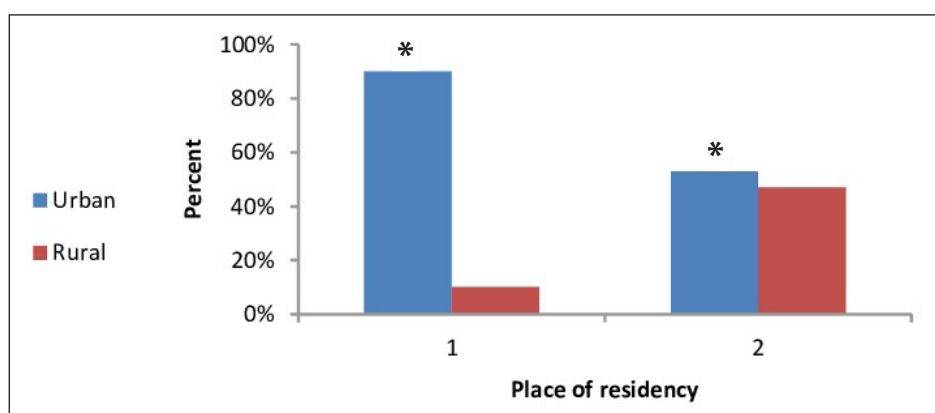
This clinical trial includes 30 patients with hypertension, 15 patients of them taking thyme to test its effect on lowering hypertension and the other 15 didn't take thyme using as control group patients to compare between their results.

### COLLECTION OF DATA

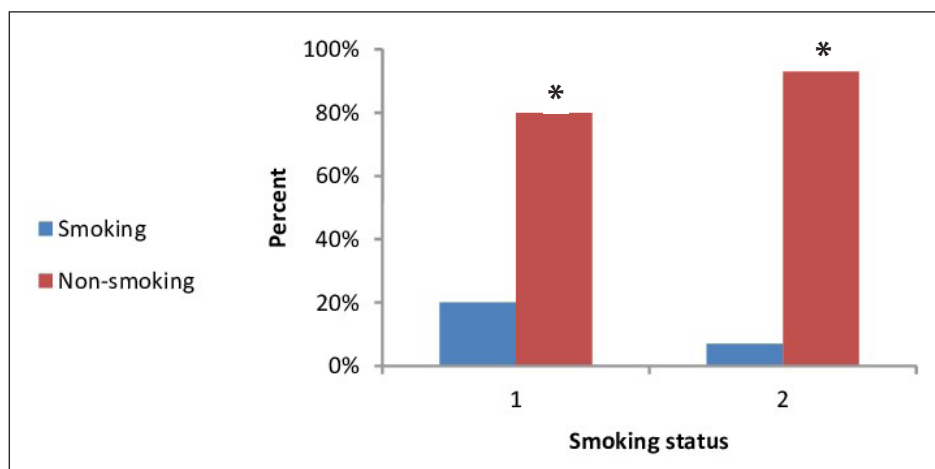
The method of data collection was depended on interviewed patients directly (personal) to get several information about them. A questionnaire paper using for this direct interview and the paper include several questions about (patients age, marital status, their level of education, job, place of residency, duration of hypertension and their diet and life style and the medication that taken by them). This direct interview also included convincing patients to take thyme for 15 days to know how could the thyme effect on their blood pressure and over different patients.



**Fig. 8.** Distribution of economic status among study population (\* - significant difference).



**Fig. 9.** Distribution of place of residency among study population (\* - significant difference).



**Fig. 10.** Distribution of smoking status among study population (\* - significant difference).

## STATISTICAL ANALYSIS

The statistical analysis was conducted using SPSS 16.0. Consultation was sought from a statistical expert for the test employed. The study involved comparing the differences between each pair using paired-sample analysis. The application of the student's t-test was facilitated through the utilization of Microsoft Office Excel 2010. A P-value below 0.05 was deemed to be statistically significant in all conducted tests.

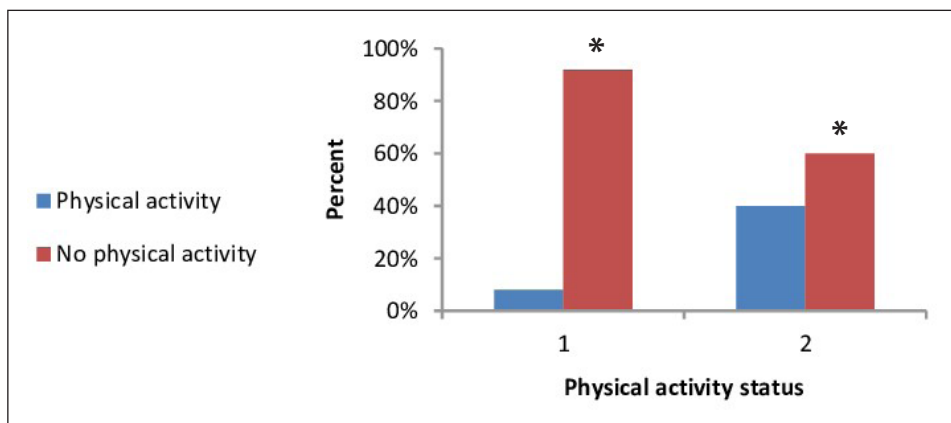
## RESULTS

### EFFECT OF GENDER DISTRIBUTION AMONG STUDY POPULATION

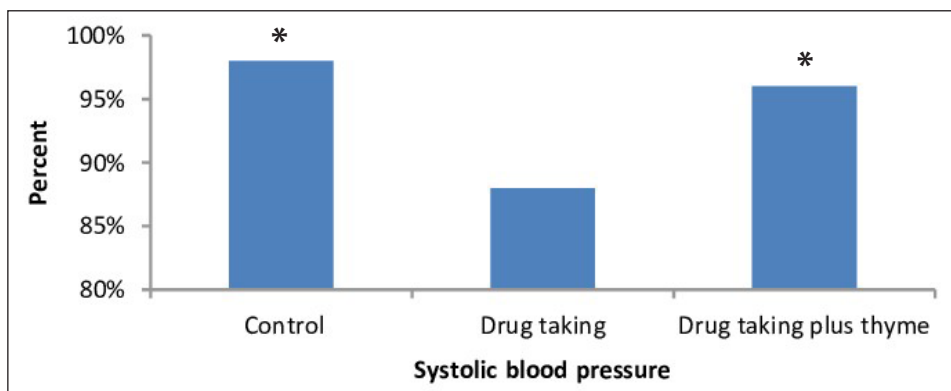
The present study reveals a significant difference in distribution between male and female within the control group and within treated group, but non-significant differences between control and treated group as shown in (Fig. 2).

### EFFECT OF AGE DISTRIBUTION AMONG STUDY POPULATION

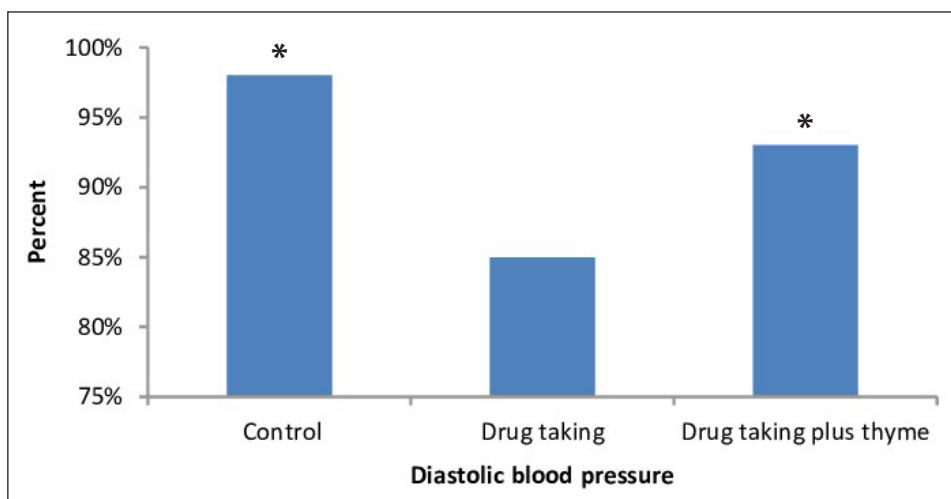
The current findings show a significant difference between age (30-50 years) as compared with age (51-70 years) but non-significant differences between age (30-50 years) as compared with age (71-90 years), in addition to that there was a significant difference between



**Fig. 11.** Distribution of physical activity status among study population (\* - significant difference).



**Fig. 12.** Distribution of systolic blood pressure among study population (\* - significant difference).



**Fig. 13.** Distribution of diastolic blood pressure among study population (\* - significant difference).

age (51-70 years) as compared with age (71-90 years) within the control group, also there was a significant difference between age (30-50 years, 51-70 years, 71-90 years) within treated group. There was a significant difference between all age groups when compared control and treated group (Fig. 3).

### EFFECT OF WEIGHT DISTRIBUTION AMONG STUDY POPULATION

The current study reported that there was a significant difference between weight (71-90 kg) as compared with weight (50-70 kg, 91-110 kg, 111-130 kg), also

significant differences between weight (50-70 kg) as compared with weight (111-130 kg), but non-significant differences between weight (91-110 kg) as compared with weight (111-130 kg) within the control group. There were non-significant differences between weight (91-110 kg) as compared with weight (111-130 kg), but significant differences between weight (91-110 kg, 111-130 kg) as compared with weight (50-70 kg, 71-90 kg), in addition to those non-significant differences between weight (50-70 kg) as compared with weight (71-90 kg) within the treated group. There was a significant difference between all weight groups when compared control and treated groups (Fig. 4).



### **EFFECT OF MARITAL STATUS DISTRIBUTION AMONG STUDY POPULATION**

The present study shows a significant difference between married and single population within control and treated groups, also there was a significant difference between married and single population between control and treated groups (Fig. 5).

### **EFFECT OF LEVEL OF EDUCATION DISTRIBUTION AMONG STUDY POPULATION**

The current study reported that there was a significant difference between primary, secondary, academic, and uneducated population within control and treated groups. There were non-significant differences between primary level of education when compared control group with treated group, but significant differences between secondary, academic, and uneducated population when compared control group with treated group (Fig. 6).

### **EFFECT JOB DISTRIBUTION AMONG STUDY POPULATION**

The findings of study show a significant difference between employee, not employee, and retired within control group. Also, there was significant differences between retired as compared with employee and not employee but non-significant differences between employee and not employee within treated group. There was a significant difference between not employee and retired but non-significant differences between employee when compare of the control and treated groups (Fig. 7).

### **EFFECT ECONOMIC STATUS DISTRIBUTION AMONG STUDY POPULATION**

The current study shows that there was a significant difference between moderate economic status as compared with poor and rich within both control and treated groups, but non-significant differences between poor, rich, and moderate economic status when compare of the control and treated groups (Fig. 8).

### **EFFECT PLACE OF RESIDENCY DISTRIBUTION AMONG STUDY POPULATION**

The findings of present study reported a significant difference between rural and urban distribution of study population within control and treated groups,

also a significant difference when compared control and treated groups (Fig. 9).

### **EFFECT SMOKING STATUS DISTRIBUTION AMONG STUDY POPULATION**

The findings of present study recorded a significant difference between smoking and non-smoking population within control and treated groups and between control group as compared with treated group (Fig. 10).

### **EFFECT OF PHYSICAL ACTIVITY STATUS DISTRIBUTION AMONG STUDY POPULATION**

The results of present study show a significant difference between physically active and non-physically active population within control and treated groups and between control group as compared with treated group (Fig. 11).

### **EFFECT OF TREATMENT ON SYSTOLIC BLOOD PRESSURE**

The findings of present study reveal a significant reduction in systolic blood pressure when patients taking own drug plus thyme in comparison with patients taking own drug alone as in figure 12.

### **EFFECT OF TREATMENT ON DIASTOLIC BLOOD PRESSURE**

The current study shows a significant reduction in diastolic blood pressure when patients taking own drug plus thyme in comparison with patients taking own drug alone (Fig. 13).

## **DISCUSSION**

In the present study of 30 hypertension patient participants aged 35 years and older, the results confirm that a significant decrease in blood pressure in patients who took thyme plus to their own medication comparing to patients taking own medications only, Thyme contains powerful compounds, rosmarinic acid is one such compound, rosmarinic acid is a natural compound that has vasorelaxant effect. Rosmarinic acid has been found to exhibit efficacy in the reduction of blood pressure. Currently, the management of blood pressure involves a combination of medical interventions and the adoption of a health-conscious lifestyle. Nevertheless, scholarly research indicates that alternative treatment modalities are frequently employed in conjunction with conven-

tional medical interventions [10]. The present study reveals a significant difference in distribution between male and female within the control group and within treated group, but non-significant differences between control and treated group (Fig. 2). This result is in consistency with the result of study [11, 12], which stated that in China, where prevalence of hypertension is observed to be higher among women compared to men, with rates of 51.9% and 42.5% respectively. Similarly, the rates of treatment and control of hypertension are also higher among women, with percentages of 46.6% and 35.6% respectively. Furthermore, when considering the usage of antihypertensive drugs, there is no significant difference in the control rates between men and women, both at 37.0% and 38.0% respectively. The data indicates that the prevalence of hypertension was found to be higher in men compared to women, with rates of 24.5% and 21.9% respectively.

The Renin-Angiotensin System (RAS) is widely recognized as a pivotal mechanism underlying gender disparities in the development and regulation of hypertension. Furthermore, it is acknowledged that sex hormones exert a significant influence on blood pressure (BP) regulation. Multiple studies have demonstrated that both endogenous and exogenous estrogens have the capacity to decrease blood pressure levels in postmenopausal women who have hypertension [13-15]. There was a significant difference between age (30-50 years, 51-70 years, 71-90 years) within treated group. There was a significant difference between all age groups when compared control and treated group (Fig. 3). This result is in consistency with the result of the study [16], which states that the general population that systolic and diastolic blood pressure increase with age and that systolic blood pressure continues to increase after the seventh decade, The decline in plasma renin levels with advancing age has been previously documented in both individuals with normal blood pressure and those with hypertension. In the current study, it was observed that there was a significant increase in plasma norepinephrine levels with advancing age. However, it is important to note that this finding may only partially reflect the expected age-related rise in plasma norepinephrine levels, as previously reported [17]. There was a significant differences between all weight groups when compared control and treated groups as shown in (Fig. 4). This findings is in similarity to the findings of the study [18], which reported that the association between weight and hypertension has been found in most populations, hypertension evaluation clinic screening of more than 1 million persons, the frequency of hypertension in self-reported overweight persons was two to three times higher than that in per-

sons of average and below-average weight individuals, who are overweight or obese experience an increase in vascular resistance due to the presence of excess fat. This, in turn, necessitates the heart to exert additional effort in order to effectively circulate blood throughout the body. Engaging in this additional activity imposes additional cardiovascular burden and leads to elevated blood pressure levels. The present study shows a significant difference between married and single population within control and treated groups (Fig. 5). This result is in consistency with the result of the study [19], research studies have indicated that unmarried males exhibit a greater susceptibility to hypertension compared to their married counterparts. Conversely, unmarried females tend to display a reduced risk of hypertension in comparison to married females.

Consequently, it can be inferred that an individual's marital status is associated with variations in their health status, particularly in relation to hypertension. The precise mechanisms that contribute to the impact of marital status on hypertension remain incompletely comprehended. Prior research has put forth various hypotheses to account for the impact of marital status, encompassing psychopathological factors, neuroendocrine pathways, health behaviors (such as physical activity, diet, and adherence), biological mediators, and immune pathways. There exists a suggestion that married men experience enhanced sleep quality, reduced stress levels, improved mood, and adopt healthier dietary habits in comparison to their never-married counterparts [20, 21]. The current study reported that there was a significant difference between primary, secondary, academic, and uneducated population within control and treated groups. There were non-significant differences between primary level of education when compared control group with treated group as shown in (Fig. 6). This result is similar to that of this study [22]. The findings indicate that individuals who have completed middle school education or higher have a reduced likelihood of developing hypertension and are more successful in managing their blood pressure compared to those with elementary school education or below. Individuals who have completed elementary school education or have a lower level of education may exhibit a higher likelihood of engaging in unhealthy lifestyle behaviors, such as consuming an imbalanced diet or having insufficient physical activity. These behaviors have been linked to the development of hypertension. Furthermore, it has been observed that individuals diagnosed with hypertension who have received an elementary school education or lower may exhibit suboptimal adherence to prescribed antihypertensive medications [23]. The findings of study show a signifi-



cant difference between employee, not employee, and retired within control group (Fig. 7).

The finding of this study was supported by study [24], which states that found a significant association between hypertension awareness and occupational status. The current study show a significant differences between moderate economic status as compared with poor and rich within both control and treated groups, but non-significant differences between poor, rich, and moderate economic status when compared control and treated groups as shown in (Fig. 8). This result is in consistency with the result of the study [25], which shown that lower economic status there is a consistent correlation between this factor and elevated blood pressure levels in the majority of research conducted in developed nations. The strength of this inverse gradient is observed to be greater and more consistently present in women as compared to men. There was a notable decrease in systolic blood pressure among patients who were administered both their own drug and thyme, as opposed to those who received only their own drug. However, this decrease was not statistically significant when compared to the control group. Additionally, there was an observed lack of statistical significance in the reduction of systolic blood pressure among patients who were administered the experimental drug, in comparison to the control group, as depicted in (Fig. 12). The present study's findings were corroborated by a previous study [26], which reported that the administration of rosmarinic acid resulted in a reduction of systolic blood pressure (SBP) specifically in hypertensive rats. This suggests that the observed effects of rosmarinic acid are limited to situations where the renin-angiotensin-aldosterone

system is excessively active, potentially through the inhibition of angiotensin-converting enzyme (ACE). The present study demonstrates a statistically significant reduction in diastolic blood pressure among patients who received a combination of their prescribed medication and thyme, as compared to patients who only received their prescribed medication. However, the decrease in diastolic blood pressure was not found to be statistically significant when compared to the control group. Additionally, there was an observed lack of statistical significance in the reduction of diastolic blood pressure among patients who were administered the experimental drug, in comparison to the control group, as depicted in figure 13.

The present study's findings are consistent with a previous study [27] that demonstrated the efficacy of compounds in reducing blood pressure in both spontaneously hypertensive rats and hypertensive humans. The administration of these compounds resulted in a significant decrease in both systolic and diastolic blood pressure. These promising results suggest that the utilization of an extract derived from *Thymus serpyllum* L. may hold potential for the treatment of hypertension in affected individuals.

## CONCLUSIONS

Based on the findings obtained, it can be inferred that thyme herbs have the ability to induce the normalization of hypertension, thereby effectively maintaining blood pressure within the typical range. The available clinical trial data provide evidence for the safe utilization of herbal preparations containing Thyme in the treatment of hypertension.

## REFERENCES

1. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics-2013 update: a report from the American Heart Association. *Circulation*. 2013;127(1):e6-e245. doi:10.1161/CIR.0b013e31828124ad
2. Sidney S, Rosamond WD, Howard VJ, et al. The "heart disease and stroke statistics--2013 update" and the need for a national cardiovascular surveillance system. *Circulation*. 2013;127(1):21-23. doi:10.1161/CIRCULATIONAHA.112.155911
3. Virani SS, Alonso A, Aparicio HJ, et al. Heart Disease and Stroke Statistics-2021 Update: A Report From the American Heart Association. *Circulation*. 2021;143(8):e254-e743. doi:10.1161/CIR.0000000000000950
4. Weber MA, Schiffrin EL, White WB, et al. Clinical practice guidelines for the management of hypertension in the community a statement by the American Society of Hypertension and the International Society of Hypertension. *J Hypertens*. 2014;32(1):3-15. doi:10.1097/HJH.0000000000000065
5. Heidenreich PA, Trogdon JG, Khavjou OA, et al. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. *Circulation*. 2011;123(8):933-944. doi:10.1161/CIR.0b013e31820a55f5
6. Smirk FH. Casual and basal blood pressures IV. Their relationship to the supplemental pressure with a note on statistical implications. *Br Heart J*. 1944;6(4):176-182. doi:10.1136/hrt.6.4.176
7. Hayn D, Sareban M, Höfer S, et al. Effect of digital tools in outpatient cardiac rehabilitation including home training-results of the EPICURE study. *Front Digit Health*. 2023;5:1150444. doi:10.3389/fdgh.2023.1150444

8. ALLHAT Officers and Coordinators for the ALLHAT Collaborative Research Group. The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial. Major outcomes in high-risk hypertensive patients randomized to angiotensin-converting enzyme inhibitor or calcium channel blocker vs diuretic: The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT). *JAMA*. 2002;288(23):2981-2997. doi:10.1001/jama.288.23.2981
9. Theodoridis X, Chourdakis M, Chrysoula L, et al. Adherence to the DASH Diet and Risk of Hypertension: A Systematic Review and Meta-Analysis. *Nutrients*. 2023;15(14):3261. Published 2023 Jul 24. doi:10.3390/nu15143261
10. Mancia G, Fagard R, Zanchetti A. Reply to blood pressure target in chronic kidney disease. *J Hypertens*. 2013;31(11):2321-2322. doi:10.1097/HJH.0b013e328365a00a
11. Escobar C, Barrios V, Alonso-Moreno FJ, et al. New blood pressure control goals, more rational but facilitating therapeutic inertia?. *J Hypertens*. 2013;31(12):2462. doi:10.1097/HJH.000000000000002
12. Caviglia AG. Hypertensive urgencies and emergencies: reducing the gap between guidelines and clinical practice. *J Hypertens*. 2014;32(9):1910-1911. doi:10.1097/HJH.0000000000000301
13. Mancia G, Fagard R. New blood pressure control goals, more rational but facilitating therapeutic inertia? : reply. *J Hypertens*. 2013;31(12):2463. doi:10.1097/HJH.0000000000000005
14. Caviglia AG. Hypertensive urgencies and emergencies: reducing the gap between guidelines and clinical practice. *J Hypertens*. 2014;32(9):1910-1911. doi:10.1097/HJH.0000000000000301
15. ESH/ESC Task Force for the Management of Arterial Hypertension. 2013 Practice guidelines for the management of arterial hypertension of the European Society of Hypertension (ESH) and the European Society of Cardiology (ESC): ESH/ESC Task Force for the Management of Arterial Hypertension. *J Hypertens*. 2013;31(10):1925-1938. doi:10.1097/HJH.0b013e328364ca4c
16. Montazeri S, Gharacheh M, Mohammadi N, et al. Determinants of Early Marriage from Married Girls' Perspectives in Iranian Setting: A Qualitative Study. *J Environ Public Health*. 2016;2016:8615929. doi:10.1155/2016/8615929
17. Causland FR, Sacks FM, Forman JP. Marital status, dipping and nocturnal blood pressure: results from the Dietary Approaches to Stop Hypertension trial. *J Hypertens*. 2014;32(4):756-761. doi:10.1097/HJH.0000000000000107
18. Sun K, Lin D, Li M, et al. Association of education levels with the risk of hypertension and hypertension control: a nationwide cohort study in Chinese adults. *J Epidemiol Community Health*. 2022;76(5):451-457. doi:10.1136/jech-2021-217006
19. Ramirez LA, Sullivan JC. Sex Differences in Hypertension: Where We Have Been and Where We Are Going. *Am J Hypertens*. 2018;31(12):1247-1254. doi:10.1093/ajh/hpy148
20. Alem AZ, Yeshaw Y, Kebede SA, et al. Spatial Distribution and Determinants of Early Marriage among Married Women in Ethiopia: A spatial and Multilevel Analysis. *BMC Womens Health*. 2020;20(1):207. doi:10.1186/s12905-020-01070-x
21. Zimmerman MA, Sullivan JC. Hypertension: what's sex got to do with it?. *Physiology (Bethesda)*. 2013;28(4):234-244. doi:10.1152/physiol.00013.2013
22. Zhong J, Basu R, Guo D, et al. Angiotensin-converting enzyme 2 suppresses pathological hypertrophy, myocardial fibrosis, and cardiac dysfunction. *Circulation*. 2010;122(7):717-728. doi:10.1161/CIRCULATIONAHA.110.955369
23. Reckelhoff JF. Gender differences in the regulation of blood pressure. *Hypertension*. 2001;37(5):1199-1208. doi:10.1161/01.hyp.37.5.1199
24. Ramezankhani A, Azizi F, Hadaegh F. Associations of marital status with diabetes, hypertension, cardiovascular disease and all-cause mortality: A long term follow-up study. *PLoS One*. 2019;14(4):e0215593. doi:10.1371/journal.pone.0215593
25. Mancia G, Kreutz R, Brunström M, et al. 2023 ESH Guidelines for the management of arterial hypertension The Task Force for the management of arterial hypertension of the European Society of Hypertension: Endorsed by the International Society of Hypertension (ISH) and the European Renal Association (ERA). *J Hypertens*. 2023;41(12):1874-2071. doi:10.1097/HJH.0000000000003480
26. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension [published correction appears in *Eur Heart J*. 2019 Feb 1;40(5):475]. *Eur Heart J*. 2018;39(33):3021-3104. doi:10.1093/eurheartj/ehy339
27. Löser B, Öner A. 2018 Update ESC/ESH-Leitlinie „Management der arteriellen Hypertonie“: Was ist für den Anästhesiologen wichtig? [2018 update ESC/ESH guidelines on management of arterial hypertension: What is important for anesthesiologists?]. *Anaesthesist*. 2019;68(5):325-328. doi:10.1007/s00101-019-0576-0

#### ORCID and contributionship:

Qayssar Joudah Fadheel: 0000-0003-3301-8357 <sup>A-B,E-F</sup>

Rusul Ahmed Mohammed: 0009-0006-9795-790X <sup>B-D</sup>

## **CORRESPONDING AUTHOR**

**Qayssar Joudah Fadheel**

Department of Pharmacology and Toxicology,  
College of Pharmacy, University of Babylon, Iraq  
e-mail: pharm.qayssar.joudah@uobabylon.edu.iq

**Received:** 24.09.2023

**Accepted:** 15.11.2023

---

**A** - Work concept and design, **B** - Data collection and analysis, **C** - Responsibility for statistical analysis, **D** - Writing the article, **E** - Critical review, **F** - Final approval of the article

 Article published on-line and available in open access are published under Creative Common Attribution-Non Commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0)