Poor Control of Blood Pressure and Therapeutic Non-Adherence as Predictors of Complications in Patients with Hypertension

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Original Article

Abstract

Background: Arterial hypertension is a chronic cardiovascular disorder that most affects the adult population and its prevalence is increasing worldwide, Poor Control along with therapeutic non-adherence can lead to early complications and worsening the adverse health outcomes and even early death hypertensive patients.

Objective: To assess the rates of poor control of blood pressure and non-adherence to antihypertensive treatment and to identify the contributing factors and associated complications

Patients and Methods: A prospective cross-sectional study conducted during the period from April 2022 to August 2023 in Al Samawa city, AlMuthanna Governorate, Iraq. A total of 148 consecutive adult Iraqi hypertensive patients who met the eligibility criteria of both genders were included. Standard definitions were applied to identify uncontrolled hypertension and non-adherence to treatment.

Results: Patients age ranged between 25 and 73 years with a mean of 51.4 ± 11.1 years. Females were relatively dominant, contributed for 54.7%. The rate of non-adherence to treatment was 38.5% and a rate of poor controlled hypertension was 39.9%. High rate of complications were reported in patients with poor adherence to treatment and poor controlled hypertension with an Odds ratio of 2.76 and 2.90, respectively, (P<0.05). Factors that associated with poor adherence to treatment and poor control of hypertension were older age (>50 years), male gender, being unmarried, resident in rural regions, low education level, smoking, larger body mass index (obesity), no family history of hypertension, longer disease duration and higher number of antihypertensive medications, in all comparisons, P. value < 0.05). Additionally, poor adherence to treatment was significantly associated with poor controlled hypertension, (P<0.05).

Conclusions: High rate of poor adherence to antihypertensive medication and poor controlled hypertension had been reported among Iraqi patients in this study, these high rates could be significant independent predictors of complications of hypertension. Different factors were associated with poor adherence to treatment and poor controlled hypertension.

Keywords: Hypertension, control, adherence to treatment, risk factors, complications

1. INTRODUCTION

Hypertension represents one of the commonest health problem across the world. Globally, it is estimated that more than 31.1% of adult population are hypertensive. In developing countries, high prevalence rates have been reported in many chronic diseases, specifically, hypertension. However, the incidence rate of hypertension tends to be more growing in women and adolescents in addition to older people (1). Based on the available data from previous Iraqi studies, almost 35- 40% of Iraqi adult population had elevated blood pressure and more than 6500 mortalities occurred in 2015 (2,3). Among the factors that have been identified and that contribute to the appearance of hypertension, various studies cite age, a high sodium intake, diets high in saturated fats, smoking, physical inactivity and the presence of chronic diseases such as obesity, dyslipidemia and diabetes (4). All over the world populations, hypertension is one of the significant modifiable risk factors of cardiovascular diseases and complications such as stroke, coronary artery diseases, heart failure, ischemic heart diseases. On the long-term, uncontrolled hypertension may lead to hypertensive cardiomyopathy, atrial fibrillation, valvular heart diseases, dementia, chronic kidney renal diseases and peripheral arterial diseases (5). Several epidemiological studies have repeatedly described an increase in the risk of cardiovascular disease as systolic and diastolic blood pressure levels increase. These studies show a positive, continuous and independent correlation between blood pressure levels and the incidence of coronary events (6). The need for a greater reduction in blood pressure levels in the hypertensive population is well established by various clinical trials. Likewise, various action protocols and clinical practice guidelines developed by different scientific organizations and societies reiterate the need to improve and achieve adequate control of arterial hypertension, which constitutes in itself the goal to be achieved (7–9). In Iraq, a national screening system for hypertension and diabetes was implemented since 2008 and it still progressing. However, till 2017, more than 850,000 cases of elevated blood pressure have been identified (3). In Iraq, the prevalence of hypertension is up to 40% and controlling hypertension is progressing, however, only 7.9% of patients were under medications and the control rate shows figures of almost 6.6% to 9.3% in men and women, respectively. Regarding these figures, the margin of variation is due to factors such as: 1) the cut-off point to establish the control figure for hypertension in older people. 2) The type of sample used in the studies;

3) The scope of the study (general population, primary care, hypertensive units, etc.); 4) Geographic areas with different prevalence; 5) Heterogeneous methodology in measuring blood pressure and, finally, the description of control rates in relation to the type of hypertensive patients (treated, diagnosed with treatment or total hypertensive patients)(3).

Previous studies suggested that controlling elevated blood pressure has significant benefits by reduction of incidence of stroke by almost 40%, myocardial infarction by 20%-25% and heart failure by about 50% (10,11). Poor or non-adherence to treatment and management plan is a major problem among Iraqi patients, the rate of incompliance may reach up to 60%, however, different factors may contribute to the poor or failure of adherence to antihypertensive treatment and management plans; first of all is the multi medications and complex treatment regimen, more frequent doses, cost of treatment, relationship between the doctor and the patient (11). Lack or inadequate control of blood pressure and other cardiovascular risk factors contribute to an increase in cardiovascular complications, which is the leading cause of death among patients who suffer from it and generates millions of hospitalization and large burden and costs on the health system in addition to the patients. The costs of hospitalization due to hypertension and its related conditions may reach thousands of $USD, for instance in USA, the average annual hospitalization cost associated with hypertension was about $2700 USD per patient (12–14) The present study aims to determine factors contribute to poor control of hypertension and the associated complications among adult Iraqi hypertensive patients

2. PATIENTS and METHODS

A cross-sectional, observational and prospective study with analytic approach was conducted during a period of 20 months from April 2022 – August 2023 in Al Samawa city, AlMuthanna Governorate.

We worked with adult patients with a confirmed diagnosis of arterial hypertension who reside in the Samawa city and neighborhoods areas who met the inclusion criteria, a sample consisting of 148 patients.

Inclusion criteria:

1. Iraqi adult patients aged 25 years or older

2. With a confirmed diagnosis of hypertension and had at least 6 months of follow up

3. Receiving antihypertensive medication

4. Residents of Samawa city and neighborhoods areas

5. Agreed for voluntarily participate in the study and provide an informed consent

Exclusion criteria:

1. Pregnant or breastfeeding women.

2. Present who had some degree of cognitive impairment or presence of mental disorders

3. Patients with malignant disease

4. Chronic inflammatory and autoimmune diseases

5. Critically ill patient

Study variables:

Independent variables included in the study and then analyzed were:

Sociodemographic variable age, gender, marital status, residence, level of education, occupation, smoking, alcohol consumption, body mass index, clinical and disease related variables which included medical history of chronic diseases and comorbidities, family history of hypertension, duration of hypertension, availability of blood pressure measurement device at home, self-monitoring of blood pressure, use of antihypertensive medications, type of treatment and number of medications used by the patients.

Adherence of patients to antihypertensive treatment:

We assessed the adherence of patients to antihypertensive treatment using the following scoring scale adopted from that released by Gebremichael et al. in 2018(15), where a total score of 21 was summed out according to the following:

1. Taking Antihypertension treatment regularly

2. Take his/her treatment at the same time

3. Use the recommended dose

Each of the above items was scored according to the number of days per week he/she adhere with as followed :

None of the days /week score of zero

One – 7 days score 1 – 7 respectively. Hence a total score would be 0 – 21 with higher score as the better. Then patients were categorized according to their total score patients with total score of 21 considered adherent while those of less than 21 were not

Definition of un/Inadequate controlled hypertension

Moreover, for purpose of this study we identified a patients to have uncontrolled or Inadequate controlled hypertension when he/she failed to achieve blood pressure (SBP<140) and (DBP < 90) who was taking antihypertensive treatment (15). However, for purpose of our study we divided the patients into two categories as: Good or poor controlled blood pressure

Ethical issues and informed consent:

Data collection and ethical issues were in accordance with the World Medical Association Declaration of Helsinki 2013 ethical principles for medical research involving human individuals. Informed consent was has been prepared by the author based on the guide and format developed by the World Health Organization, Researches Ethics Review Committee .

Data processing and statistical analysis plan

The data of the patients participating in the study were processed in Excel spreadsheets and then transferred to Statistical Package Software; (SPSS version 28). Statistical tests were applied accordingly; Parametric and non-parametric tests used according to the type of variable and statistical normal distribution at a level of significance of ≤ 0.05 to be considered significant

3. RESULTS

A total of 148 Iraqi patients with confirmed hypertension diagnosis were recruited. Age of the patients ranged between 25 – 73 years, with a mean of 51.4 ± 11.1 years, and 56.1% were older than 50 years. Females were relatively dominant and contributed for 54.7% of the studied group. Among our patients, 59 had poor control of their blood pressure, detected by measuring their blood pressure at the time of inclusion and from their medical history. This giving up to a poor control rate of 39.9%. Regarding the adherence to antihypertensive medication, 57 patients were non-adherent to treatment giving a rate of 38.5%, (**Table 1**). The cross-tabulation between independent variables from one side against the control of blood pressure (BP) from the other side revealed that older age (>50 years) was significantly associated with poor control of BP and non-adherence to antihypertensive treatment compared to younger age of ≤ 50 years, (P. value <0.05). Other factors associated with poor control and non-adherence to treatment were female gender, being married, resident in rural regions, low level of education, being smoker, obese, and having negative family history, in all comparisons, (P. value <0.05). Occupation did not show a significant association with both of control of BP and adherence to

treatment, (P. value >0.05), (**Tables 2 & 3**). The association between diseases related variables and each of control of BP and adherence to treatment among hypertensive patients were assessed with cross-tabulation and chi-square test analysis which revealed that longer duration of hypertension since diagnosis of > 5 years was significantly associated with poor control of BP where the rate of poor control of BP in patients with a duration of disease of > 5 years was 48.5% compared to 36.8% and 21.7% in those with a duration of 3-5 years and 1-2 years, respectively, (P. value <0.05). A significant association was found between using multiple antihypertensive medications of three or more medications and poor control of hypertension, where 64.3% of patients who used three or more medications had poor control of BP compared to 34.3% of those using two medications and 23.1% among those use single medication, (P. value <0.05), (**Table 4**). Similarly, both longer duration of disease and multiple medication use of three or more were significantly associated with non-adherence to antihypertensive treatment, (P. value < 0.05), (**Tables 5**). Among the studied group, complications were present in 43 patients and represented 29.1% of the total hypertensive patients, (**Figure 1**). Furthermore, presence of complications was significantly associated with poor control of BP and non-adherence to treatment. Odds ratio was calculated for each association and revealed that patients with poor control BP were about 2.76 fold more likely to have complications compared to those with good control of BP, (OR = 2.76, P. value = 0.004), (**Table 6**). For relationship between presence of complications and adherence to treatment, it had been found that patients who were non-adherent to treatment were about 3-fold more likely to have complications compare to adherent patients, (Odds ratio = 2.90), P. value = 0.006), (**Table 7**). Which reflected that poor control of BP and non-adherence to treatment were independent predictors of incident complications.

Table 1. Rates of Blood pressure (BP) control and adherence to antihypertensive treatment of the studied group (N=148).

Variable		No.	%
Control Blood pressure	Poor	59	39.9
	Good	89	60.1
Adherence to treatment	Not adhere	57	38.5
	Adhere	91	61.5

Table 2. Cross-tabulation for the independent factors associated with control of hypertension among hypertensive patients (N=148)

Variable		Control of hypertension				Total		P. value
		Good (n=89)		Poor (n=59)				
		No.	%	No.	%	No.	%	
Age (year)	≤ 50	48	73.8	17	26.2	65	43.9	0.003
	> 50	41	49.4	42	50.6	83	56.1	
Gender	Male	33	49.3	34	50.7	67	45.3	0.014
	Female	56	69.1	25	30.9	81	54.7	
Marital status	Married	68	55.3	55	44.7	123	83.1	0.008
	Unmarried	21	84.0	4	16.0	25	16.9	
Residence	Urban	73	64.6	40	35.4	113	76.4	0.046
	Rural	16	45.7	19	54.3	35	23.6	
Education	None	5	41.7	7	58.3	12	8.1	0.027
	Primary	12	44.4	15	55.6	27	18.2	
	Secondary	37	60.7	24	39.3	61	41.2	
	Above secondary	35	72.9	13	27.1	48	32.4	
Occupation	Employed	42	61.8	26	38.2	68	45.9	0.811
	Unemployed	27	61.4	17	38.6	44	29.7	
	Retired	20	55.6	16	44.4	36	24.3	
Smoking	Yes	20	45.5	24	54.5	44	29.7	0.018
	No	69	66.3	35	33.7	104	70.3	
BMI	Normal	49	71.0	20	29.0	69	46.6	0.001
	Overweight	35	60.3	23	39.7	58	39.2	
	Obese	5	23.8	16	76.2	21	14.2	
Family history	Yes	34	69.4	15	30.6	49	33.1	0.022
	No	55	55.6	44	44.4	99	66.9	

Table 3. Cross-tabulation for the independent factors associated with adherence to treatment among hypertensive patients (N=148)

Variable		Adhere (n=91)		Not adhere (n=57)		Total		P. value
		No.	%	No.	%	No.	%	
Age (year)	≤ 50	46	70.8	19	29.2	65	43.9	0.040
	> 50	45	54.2	38	45.8	83	56.1	
Gender	Male	35	52.2	32	47.8	67	45.3	0.035
	Female	56	69.1	25	30.9	81	54.7	
Marital status	Married	71	57.7	52	42.3	123	83.1	0.037
	Unmarried	20	80.0	5	20.0	25	16.9	
Residence	Urban	76	67.3	37	32.7	113	76.4	0.010
	Rural	15	42.9	20	57.1	35	23.6	
Education	None	5	41.7	7	58.3	12	8.1	0.044
	Primary	12	44.4	15	55.6	27	18.2	
	Secondary	39	63.9	22	36.1	61	41.2	
	Above secondary	35	72.9	13	27.1	48	32.4	
Occupation	Employed	42	61.8	26	38.2	68	45.9	0.887
	Unemployed	28	63.6	16	36.4	44	29.7	
	Retired	21	58.3	15	41.7	36	24.3	
Smoking	Yes	19	43.2	25	56.8	44	29.7	0.003
	No	72	69.2	32	30.8	104	70.3	
BMI	Normal	51	73.9	18	26.1	69	46.6	0.001
	Overweight	34	58.6	24	41.4	58	39.2	
	Obese	6	28.6	15	71.4	21	14.2	
Family history	Yes	36	73.5	13	26.5	49	33.1	0.005
	No	55	55.6	44	44.4	99	66.9	

Table 4. Cross-tabulation for the association between diseases related variables and control of hypertension among hypertensive patients (N=148)

Variable		Control of hypertension				Total		P. value
		Good (n=89)		Poor (n=59)				
		No.	%	No.	%	No.	%	
Disease duration	1 - 2	18	78.3	5	21.7	23	15.5	0.032
	3 - 5	36	63.2	21	36.8	57	38.5	
	> 5	35	51.5	33	48.5	68	45.9	
Number of medications	One	30	76.9	9	23.1	39	26.4	0.001
	Two	44	65.7	23	34.3	67	45.3	
	Three and more	15	35.7	27	64.3	42	28.4	

Table 5. Cross-tabulation for the association between diseases related variables and adherence to treatment among hypertensive patients (N=148)

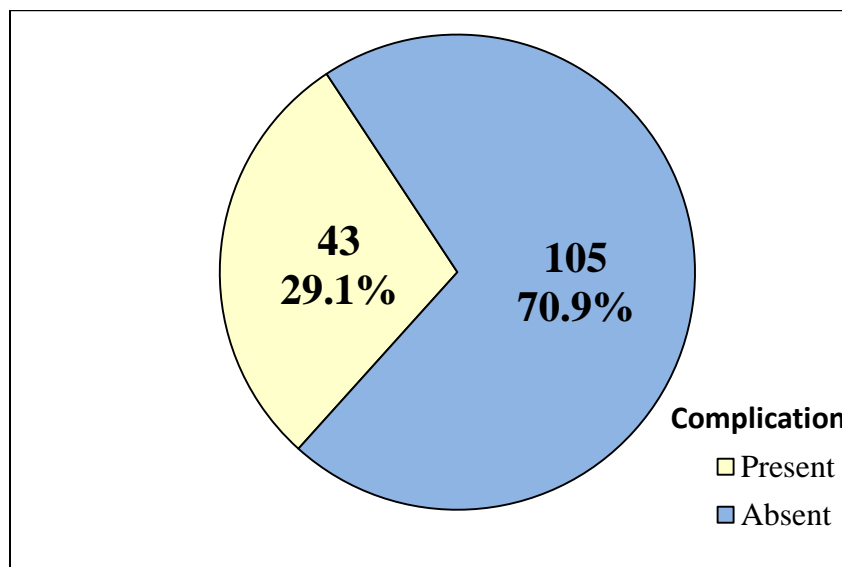| Variable		Adherence to treatment				Total		P. value
		Adhere (n=91)		Not adhere (n=57)				
		No.	%	No.	%	No.	%	
Disease duration	1 - 2	18	78.3	5	21.7	23	15.5	0.032
	3 - 5	38	66.7	19	33.3	57	38.5	
	> 5	35	51.5	33	48.5	68	45.9	
Number of medications	One	32	82.1	7	17.9	39	26.4	0.001
	Two	45	67.2	22	32.8	67	45.3	
	Three and more	14	33.3	28	66.7	42	28.4	

Figure 1. Distribution of complications reported among the studied group (N=148)

Table 6. Cross-tabulation for the relationship between presence of complications and control of hypertension

| Control of hypertension | Complication | | | | Total | |
| | Present | | Absent | | | |
	No.	%	No.	%	No.	%
Poor	25	58.1	34	32.4	59	60.1
Good	18	41.9	71	67.6	89	39.9
Total	43	100.0	105	100.0	148	100.0

OR = 2.90 (95%CI:1.40 - 6.02), P. value = 0.004

Table 7. Cross-tabulation for the relationship between presence of complications and adherence to treatment

| Adherence to treatment | Complications | | | | Total | |
| | Present | | Absent | | | |
	No.	%	No.	%	No.	%
Not adhere	24	55.8	33	31.4	57	61.5
Adhere	19	44.2	72	68.6	91	38.5
Total	43	100.0	105	100.0	148	100.0

OR = 2.76 (95%CI:1.33 - 5.72), P. value = 0.006

4. DISCUSSION

Hypertension is a chronic cardiovascular disorder that with no doubt mostly affects the adult population worldwide and being one of the causes of complications and early death. According to recent estimates, hypertension is recognized in the top of the list of the most frequent modifiable risk factor for a group of hypertensive heart diseases and premature mortalities from these diseases (16) this fact intensify the need for continuous surveillance and regular monitoring for prevention, early detection or slowing the development of complications and adverse health consequences , several cardiovascular diseases can developed as a consequence of prolonged hypertension particularly in poorly or inadequately controlled blood pressure and poor or non-adherence to antihypertensive treatment (17). Uncontrolled hypertension represents a challenge in the daily practice of clinicians, different factors may contribute to poor control of BP. However, despite the availability and development of several therapeutic and diagnostic modalities for hypertension, the rates of controlled BP are still in low levels

where it is generally not exceed 30% in many populations and the global estimates indicated that increasing the rate of controlled hypertension to 50% of all hypertensive patients will prevent 76 million deaths in the next 25 years (18). The World Health Organization, put in 2013 a goal to reduce the prevalence of hypertension by 25% by the year 2025 (19). Therefore, good control and therapeutic adherence in hypertension patients is of great importance not only for the patients but for their families and the health system, hence assessment of the control rates of hypertension and the possible associated factors is necessary for management planning and prevention strategies particularly in developing countries. In Iraq, studies that assessed this topic are scarce and not widely conducted, which represent a solid base to conduct this study. We included a total of 148 patients with hypertension and we found that the rate of uncontrolled hypertension was 39.9% which is considered high when taking into account that our study is hospital based and it may not reflect the exact rate in the total population of patients with hypertension, however, previous studies reported rates that were close to our findings; a study from Ethiopia (20) documented a rate of 37%. Our findings was lower than that reported in Thailand by Sangsuwan et al. in 2018 (21), who found a rate of uncontrolled blood pressure of 53.4%. This variation in the rates can be attributed to the variation in the populations of these studies and the definitions and cut-off values of blood pressure that been used to define the uncontrolled blood pressure . On the other hand the rates of uncontrolled hypertension much varied globally, it was up to 82% in Morocco (22) and 75.5% in South Africa (23), additionally, earlier study reported a rate of 31% of uncontrolled hypertension among US adults (24). Regarding the adherence to antihypertensive treatment, we found that 38.5% of our patients were non-adherent to treatment. Compared to previous studies this rate was in line with the findings of these studies; Choudhary et al. documented a low adherence in 45.6% of patients (25) Pallangyo et al reported that 76.9% had good therapeutic adherence with anti-hypertensive medications in Tanzanian patients (26). Regarding the factors that associated with the low adherence and poor controlled hypertension we found that older age (>50 years) , female gender, being married, resident in rural regions, low level of education, being smoker, obese, and having negative family history were significant factors associated with poor control of BP and poor adherence to treatment. On the other hand we also observed that longer duration of hypertension since diagnosis of > 5 years and using

multiple antihypertensive medications of three or more were significantly associated with poor control of hypertension and non-adherence to treatment, these findings, agreed that reported in previous studies where these variables have been documented as risk factors (15,17,21,26,27). We observed, that presence of complications was significantly associated with poor control of BP and non-adherence to treatment where the patients with poor control BP were about 2.76 fold more likely to have complications compared to those with good control of BP, (OR = 2.76, P. value = 0.004). Moreover, patients who were non-adherent to treatment were about 3-fold more likely to have complications compared to adherent patients, (Odds ratio = 2.90), P. value = 0.006). These findings reflected that poor control of BP and non-adherence to treatment were independent predictors of incident complications, these findings were not unexpected because almost all previous studies stated that uncontrolled hypertension and poor adherence to treatment associated with many cardiovascular complications (12,15–17,21,26–28). Finally, we have to address limitations, the nature and design of our study, the cross-sectional and hospital based design may carry some disadvantage in regard to the generalization of our findings. Moreover, the temporal relationship between the possible risk factors and the outcomes cannot be shown in this type of studies. However, further studies particularly case-control or cohort studies can resolve these limitations.

5. CONCLUSIONS

High rate of poor adherence to antihypertensive medication and poor controlled hypertension had been reported among Iraqi patients in this study, these high rates could be significant independent predictors of complications of hypertension. Different factors were associated with poor adherence to treatment and poor controlled hypertension.

Ethical Clearance:

Ethical issues were taken from the research ethics committee. Informed consent was obtained from each participant. Data collection was in accordance with the World Medical Association (WMA) declaration of Helsinki for the Ethical Principles for Medical Research Involving Human Subjects, 2013 and all information and privacy of participants were kept confidentially.

Conflict of interest: Authors declared none

6. *REFERENCES*

1. *Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020 Apr;16(4):223–37.*

2. *Hasan MYA, Tawfeeq WF, Alfarttoosi AJ. Screening for Hypertension among Adults Attending Primary Health Care Centers in Baghdad. Iraqi Med J. 2021;67(1):20–5.*

3. *Ali MAK, Al-Badri HJA, Mousa NAW. Hypertension Control among Adult Iraqis. J Fac Med Baghdad. 2022;64(3):145–52.*

4. *Nawi AM, Mohammad Z, Jetly K, Razak MAA, Ramli NS, Hannan WA, et al. The Prevalence and Risk Factors of Hypertension among the Urban Population in Southeast Asian Countries: A Systematic Review and Meta-Analysis. Int J Hypertens. 2021;2021(1):6657003–16.*

5. *Fuchs FD, Whelton PK. High Blood Pressure and Cardiovascular Disease. Vol. 75, Hypertension. 2020. p. 285–92.*

6. *Zhou B, Perel P, Mensah GA, Ezzati M. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. Nat Rev Cardiol [Internet]. 2021;18(11):785–802. Available from: https://doi.org/10.1038/s41569-021-00559-8*

7. *Chobanian A V, Bakris GL, Black HR, Cushman WC, Green LA, Izzo Jr JL, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. Jama. 2003;289(19):2560–71.*

8. *Jones NR, McCormack T, Constanti M, McManus RJ. Diagnosis and management of hypertension in adults: NICE guideline update 2019. Br J Gen Pract. 2020;70(691):90–1.*

9. *Carey RM, Wright Jr JT, Taler SJ, Whelton PK. Guideline-driven management of hypertension: an evidence-based update. Circ Res. 2021;128(7):827–46.*

10. *Rahimi K, Bidel Z, Nazarzadeh M, Copland E, Canoy D, Wamil M, Majert J, McManus R, Adler A, Agodoa L AA. Age-stratified and blood-pressure-stratified effects of blood-pressure-lowering pharmacotherapy for the prevention of cardiovascular disease and death: an individual participant-level data meta-analysis. lancet2021. 2021;398(32):1053–64.*

11. *Section D of PHN communicable D. Steering Committee of the Non-Communicable Diseases, Directorate of Public Health Non-communicable Disease Section, MOH-Iraq in corboration with the USAID Primary Health Care Project. Hypertension Prevention, Diagnosis, and Treatment. National Guidelines [Internet]. Baghdad-Iraq; 2012. Available from: https://phd.iq/LionImages/PDFStore/2Hypertension-MOH*

12. *Elliott WJ. What factors contribute to the inadequate control of elevated blood pressure? J Clin Hypertens (Greenwich). 2008 Jan;10(1 Suppl 1):20–6.*

13. *Adler AJ, Prabhakaran D, Bovet P, Kazi DS, Mancia G, Mungal-Singh V, et al. Reducing cardiovascular mortality through prevention and management of raised blood pressure. Glob Hear. 2015;10(2):111–22.*

14. *Wang G, Zhang Z, Ayala C. Hospitalization costs associated with hypertension as a secondary diagnosis among insured patients aged 18–64 years. Am J Hypertens. 2010;23(3):275–81.*

15. *Gebremichael GB, Berhe KK, Zemichael TM. Uncontrolled hypertension and associated factors among adult hypertensive patients in Ayder comprehensive specialized hospital, Tigray, Ethiopia, 2018. BMC Cardiovasc Disord [Internet]. 2019;19(1):121. Available from: https://doi.org/10.1186/s12872-019-1091-6*

16. *Masenga SK, Kirabo A. Hypertensive heart disease: risk factors, complications and mechanisms. Front Cardiovasc Med. 2023;10:1205475.*

17. *Adomako NO, Marfo AFA, Opare-Addo MNA, Nyamekye N, Owusu-Daaku FT. Blood Pressure Control, Accessibility, and Adherence to Antihypertensive Medications: Patients Seeking Care in Two Hospitals in the Ashanti Region of Ghana. Int J Hypertens [Internet]. 2021 Jan 1;2021(1):9637760. Available from: https://doi.org/10.1155/2021/9637760*

18. *World Health Organization. Global report on hypertension: the race against a silent killer. World Health Organization; 2023.*

19. *World Health Organization. Global action plan for the prevention and control of noncommunicable diseases 2013–2020. [Internet]. 2013. Available from: http://africahealthforum.afro.who.int/first-edition/IMG/pdf/global_action_plan_ for_the_prevention_an.*

20. *Abdu O, Diro E, Abera Balcha MA, Ayanaw D, Getahun S, Mitiku T, et al. Blood pressure control among hypertensive patients in University of Gondar Hospital, Northwest Ethiopia: a cross sectional study. Hypertension. 2017;140(1):6.*

21. *Sangsuwan T, Jamulitrat S. Prevalence of uncontrolled blood pressure in hypertensive patients attending the primary care unit of songklanagarind hospital. Vol. 36, Journal of Health Science and Medical Research. 2018. p. 11–27.*

22. *Berraho M, El Achhab Y, Benslimane A, Rhazi KE, Chikri M, Nejjari C. Hypertension and type 2 diabetes: a cross-sectional study in Morocco (EPIDIAM study). Pan Afr Med J. 2012;11(1):52.*

23. *Adeniyi OV, Yogeswaran P, Longo-Mbenza B, Ter Goon D. Uncontrolled hypertension and its*

determinants in patients with concomitant type 2 diabetes mellitus (T2DM) in rural South Africa. PLoS One. 2016;11(3):e0150033.

24. *Egan BM, Zhao Y, Axon RN. US trends in prevalence, awareness, treatment, and control of hypertension, 1988-2008. JAMA. 2010 May;303(20):2043–50.*

25. *Choudhary R, Sharma SM, Kumari V, Gautam D. Awareness, treatment adherence and risk predictors of uncontrolled hypertension at a tertiary care teaching hospital in Western India. Indian Heart J. 2016 Sep;68 Suppl 2(Suppl 2):S251–2.*

26. *Pallangyo P, Komba M, Mkojera ZS, Kisenge PR, Bhalia S, Mayala H, et al. Medication Adherence and Blood Pressure Control Among Hypertensive Outpatients Attending a Tertiary Cardiovascular Hospital in Tanzania: A Cross-Sectional Study. Integr Blood Press Control. 2022;15:97–112.*

27. *Nassr OA, Forsyth P. Evaluation of blood pressure control and associated factors among patients with hypertension in Iraq: A prospective cross-sectional study. J Pharm Bioallied Sci. 2019;11(3):232–9.*

28. *Dantas RC de O, Silva JPT da, Dantas DC de O, Roncalli ÂG. Factors associated with hospital admissions due to hypertension. Vol. 16, Einstein (Sao Paulo, Brazil). 2018. p. eAO4283.*