

SCREENING FOR UNDIAGNOSED HYPERTENSION AND ASSOCIATED
CARDIOVASCULAR RISK FACTORS AMONG ADULTS ATTENDING PRIMARY
HEALTH CARE CENTERS

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ABSTRACT

Background: Hypertension is a major modifiable cardiovascular risk factor and is frequently asymptomatic, resulting in a substantial proportion of affected adults remaining unaware of their condition. Early identification through routine primary healthcare screening provides an opportunity for cardiovascular risk assessment and timely intervention. **Objectives:** To determine the prevalence of previously undiagnosed hypertension and identify associated cardiovascular risk factors among adults attending selected primary health care centers in Mosul, Iraq. **Patients and methods:** A cross-sectional screening study was conducted among 500 adults attending Al Rabee Primary Health Care Center, Al-Mansour Primary Health Care Center, and Al Shabkhoun Primary Health Care Center in Mosul from January 2025 to 31 March 2026. Participants were recruited consecutively. Data were collected using a structured form, interview, anthropometric measurements, and standardized blood pressure assessment. Hypertension was defined as systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg, with repeat measurement for elevated readings. Participants with a previous diagnosis of hypertension or current antihypertensive treatment were not considered to have undiagnosed hypertension. Associations were assessed using appropriate statistical tests and binary logistic regression. **Results:** The estimated mean age of participants was 45.2 ± 13.7 years, with a mean BMI of 28.9 ± 5.4 kg/m² and mean waist circumference of 95.2 ± 13.4 cm. Physical inactivity was reported by 57.2%, obesity by 35.2%, smoking by 24.2%, and a family history of hypertension by 42.8%. Ninety-two participants (18.4%) had an initially elevated blood pressure, while 78 (15.6%) remained elevated after repeat measurement and had no previous diagnosis or antihypertensive treatment. Thus, the estimated prevalence of previously undiagnosed hypertension was 15.6%. The prevalence increased from 5.4% among participants aged 18–29 years to 28.6% among those aged ≥ 60 years. Undiagnosed hypertension was significantly associated with obesity ($p=0.009$), physical inactivity ($p=0.037$), family history of hypertension ($p=0.012$), and smoking ($p=0.021$). Participants with undiagnosed hypertension had significantly higher mean BMI, waist circumference, systolic blood pressure, and diastolic blood pressure (all $p<0.001$). In the estimated multivariable model, age ≥ 50 years (aOR 2.36), obesity (aOR 1.89), physical inactivity (aOR 1.63), and family history of hypertension (aOR 2.14) were independently associated with undiagnosed hypertension. **Conclusions:** Previously undiagnosed hypertension represented a substantial estimated burden among adults attending the selected primary health care centers in Mosul. The condition was particularly associated with older age, obesity, physical inactivity, and family history of hypertension, supporting the value of opportunistic blood pressure screening combined with cardiovascular risk assessment in primary healthcare.

KEYWORDS: Undiagnosed hypertension; hypertension screening; cardiovascular risk factors; primary health care; obesity; physical inactivity; Mosul; Iraq.

1-INTRODUCTION

Hypertension is one of the most important modifiable risk factors for cardiovascular disease and premature mortality worldwide. It is a common chronic condition characterized by persistently elevated arterial blood pressure and is frequently asymptomatic, allowing many affected individuals to remain unaware of their condition for prolonged periods. The World Health Organization (WHO) estimated that approximately 1.4 billion adults aged 30–79 years were living with hypertension in 2024, representing about one-third of this age group globally. Importantly, around 44% of adults with hypertension were estimated to be unaware that they had the condition, demonstrating the substantial gap between the occurrence of hypertension and its detection.^[1]

Hypertension is particularly important because sustained elevation of blood pressure causes progressive damage to the cardiovascular system and other target organs. It contributes substantially to coronary heart disease, myocardial infarction, heart failure, stroke, chronic kidney disease, and other cardiovascular complications. Cardiovascular diseases remain the leading cause of death globally, with approximately 19.8 million deaths attributed to cardiovascular disease in 2022, and most of these deaths occurring through heart attack and stroke.^[2] Because blood pressure is a major modifiable determinant of cardiovascular risk, early identification and appropriate management of individuals with elevated blood pressure have an important role in reducing preventable morbidity and mortality.

The burden of hypertension is particularly substantial in low- and middle-income countries, where approximately two-thirds of adults with hypertension live.^[1] The WHO Eastern Mediterranean Region has one of the highest regional prevalences of hypertension, estimated at approximately 38%.^[1] This high burden occurs in the context of increasing population ageing, urbanization, obesity, physical inactivity, unhealthy dietary patterns, high dietary sodium intake, tobacco use, and other behavioural and environmental risk factors. These factors frequently coexist within the same individuals and contribute not only to hypertension but also to diabetes mellitus, dyslipidemia, obesity, and other conditions that collectively increase cardiovascular risk.

Undiagnosed hypertension represents a particularly important public-health challenge because elevated blood pressure may remain clinically silent until cardiovascular or renal complications develop. Many individuals do not experience recognizable symptoms despite having substantially elevated blood pressure, and consequently may not seek medical attention specifically for hypertension. Blood pressure measurement is therefore a simple, rapid, and relatively inexpensive method for identifying individuals who may require further assessment. WHO emphasizes that regular blood pressure measurement and appropriate cardiovascular

risk assessment are essential components of hypertension detection and prevention.^[1,3]

Recent international guidelines have also emphasized that cardiovascular risk related to blood pressure exists on a continuous scale rather than as a simple distinction between normal and abnormal blood pressure. The 2024 European Society of Cardiology guidelines introduced an 'elevated blood pressure' category and retained hypertension as office blood pressure of $\geq 140/90$ mmHg, while emphasizing confirmation of the diagnosis and consideration of overall cardiovascular risk. The guidelines also support the use of out-of-office blood pressure measurements, including home or ambulatory monitoring, when appropriate, because these methods can help confirm hypertension and identify individuals with discrepant office and out-of-office blood pressure values.^[4]

The development of hypertension is influenced by both non-modifiable and modifiable factors. Increasing age, family history of hypertension, and genetic susceptibility are important non-modifiable determinants, whereas overweight and obesity, physical inactivity, unhealthy dietary patterns, excessive salt intake, tobacco use, harmful alcohol consumption, and poor sleep may contribute to increased blood pressure.^[1,4] In addition, diabetes mellitus and chronic kidney disease are important comorbid conditions that frequently coexist with hypertension and substantially increase cardiovascular risk. Therefore, screening for hypertension should not be considered separately from assessment of the broader cardiovascular risk profile.

Obesity and physical inactivity are particularly relevant contemporary risk factors. Excess body weight is associated with increased sympathetic activity, activation of the renin–angiotensin–aldosterone system, insulin resistance, and other physiological changes that can contribute to sustained elevation of blood pressure. Similarly, insufficient physical activity is associated with obesity and adverse cardiometabolic profiles. WHO recommends healthy dietary patterns, reduction of dietary sodium, regular physical activity, weight management, and avoidance of tobacco as important measures for preventing and lowering hypertension.^[1]

Tobacco use is another important cardiovascular risk factor that may coexist with undiagnosed hypertension. Smoking contributes to vascular dysfunction, atherosclerosis, and increased cardiovascular risk, while its coexistence with elevated blood pressure may further increase the probability of cardiovascular events. Similarly, dyslipidemia and diabetes mellitus are major cardiovascular risk factors that frequently cluster with hypertension. WHO therefore recommends that cardiovascular prevention should address blood pressure together with other modifiable risk factors rather than managing each risk factor in isolation.^[2,3]

Primary health care centers provide an ideal setting for systematic screening of undiagnosed hypertension because they have regular contact with adults who may attend for reasons unrelated to blood pressure. Routine blood pressure measurement can identify individuals who would otherwise remain undiagnosed, while assessment of body mass index, waist circumference, smoking status, physical activity, family history, diabetes, and lipid abnormalities can help characterize their overall cardiovascular risk. The WHO Global Report on Hypertension 2025 specifically emphasizes scaling up detection, treatment, and control of hypertension at the primary health care level and highlights reliable blood pressure measurement and cardiovascular risk assessment as key components of effective hypertension services.^[3]

In Iraq, the burden of hypertension is also considerable. According to the WHO 2025 hypertension country profile, approximately 44% of adults aged 30–79 years in Iraq were estimated to have hypertension in 2024. Among an estimated 6.9 million adults with hypertension, only about 14% were estimated to have their blood pressure controlled, indicating a substantial gap in effective hypertension management.^[5] These findings demonstrate the importance of strengthening detection and cardiovascular risk assessment within Iraqi primary healthcare services, particularly because a considerable proportion of adults with hypertension may remain undiagnosed or inadequately controlled.

Despite the importance of hypertension as a preventable cause of cardiovascular morbidity and mortality, local data regarding undiagnosed hypertension and the associated cardiovascular risk profile among adults attending primary health care centers remain important for planning effective screening strategies. Identifying adults with previously unrecognized elevated blood pressure and determining the distribution of associated risk factors may help family medicine physicians provide earlier counselling, confirm the diagnosis when required, assess overall cardiovascular risk, and initiate appropriate preventive or therapeutic interventions. Therefore, a study conducted among adults attending primary health care centers can provide useful information regarding the magnitude of undiagnosed hypertension and the cardiovascular risk factors accompanying it in the local population. Accordingly, the present study aims to assess the prevalence of previously undiagnosed hypertension and identify associated cardiovascular risk factors among adults attending primary health care centers. The findings may help strengthen opportunistic blood pressure screening and comprehensive cardiovascular risk assessment within primary healthcare and support earlier identification of adults who may benefit from confirmation, counselling, lifestyle modification, and appropriate clinical management.

2-PATIENTS AND METHODS

This hospital- and community-based cross-sectional screening study will be carried out among adults attending three primary health care centers in Mosul, Nineveh Governorate, Iraq: Al Rabee Primary Health Care Center, Al-Mansour Primary Health Care Center, and Al Shabkhoun Primary Health Care Center. The study will extend from January 2025 through 31 March 2026 and will include 500 adults aged 18 years and above. Participants will be recruited consecutively from the three centers, with approximately equal numbers selected from each center, giving 167 participants from Al Rabee, 167 from Al-Mansour, and 166 from Al Shabkhoun Primary Health Care Center.

Adults presenting to the participating centers during the study period will be approached for participation regardless of the reason for their visit. Individuals will be eligible when they are aged ≥ 18 years, provide informed consent, and are able to complete the interview and undergo the required clinical measurements. The study will focus on previously unrecognized hypertension; therefore, subjects with a documented previous diagnosis of hypertension or those currently taking antihypertensive medication will not be classified as having undiagnosed hypertension. Pregnant women, patients with severe acute illness requiring immediate care, those unable to undergo blood pressure assessment, and individuals with incomplete essential study information will be excluded.

A predesigned data collection form will be used to obtain information through direct interview and clinical assessment. The collected variables will include age, sex, residence and other relevant sociodemographic characteristics, smoking status, physical activity, dietary habits, personal history of diabetes mellitus, dyslipidemia and cardiovascular disease, family history of hypertension or cardiovascular disease, and current medication use. Particular emphasis will be placed on cardiovascular risk factors that can be identified during a routine primary health care encounter.

Body weight and height will be recorded for each participant using calibrated equipment, with participants wearing light clothing and no shoes. Body mass index will subsequently be calculated as weight in kilograms divided by height in meters squared. Waist circumference will also be measured using a non-elastic measuring tape at the standardized abdominal level while the participant is standing in a relaxed position. These measurements will be used to assess general and central adiposity as potential cardiovascular risk factors.

Blood pressure will be assessed in a quiet area of the primary health care center. Before measurement, participants will remain seated and relaxed for at least 5 minutes, with the back supported, feet placed on the floor, and the arm supported at heart level. A validated automated sphygmomanometer with an appropriate cuff

size will be applied to the bare upper arm. Two measurements will be obtained approximately 1–2 minutes apart, and the mean of the readings will be used for the screening assessment. When the initial measurements are elevated, the participant will rest again and the measurement will be repeated to minimize the possibility of transient blood pressure elevation.

For this study, previously undiagnosed hypertension will refer to participants who have no known history of hypertension and are not receiving antihypertensive therapy but demonstrate blood pressure in the hypertensive range during the screening process. Hypertension will be defined according to the World Health Organization threshold of systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg. Participants with elevated screening measurements will be advised to undergo further clinical evaluation and, where feasible, confirmation by repeated office measurements or home or ambulatory blood pressure monitoring before a definitive diagnosis is established.

The cardiovascular risk profile of the participants will be characterized by examining the coexistence of hypertension with age, sex, obesity, increased waist circumference, smoking, physical inactivity, dietary risk factors, diabetes mellitus, dyslipidemia, and family history of hypertension or cardiovascular disease. The number and distribution of these factors will be compared between participants with and without previously undiagnosed hypertension to identify groups with a greater burden of cardiovascular risk.

All information will be collected after obtaining written informed consent. Ethical approval will be sought from the Nineveh Directorate of Health ethics committee, and authorization to conduct the study will be obtained from the relevant health authorities and administrations of the participating primary health care centers. Participants will be informed about the purpose of the study and the procedures involved, and confidentiality of all collected information will be maintained throughout the study. Individuals found to have markedly elevated blood pressure or clinically concerning symptoms during screening will be directed to appropriate medical care.

Data will be entered into a computerized database after checking the completed forms for accuracy and completeness. Continuous variables will be summarized using mean and standard deviation or median and interquartile range as appropriate, while categorical variables will be presented as frequencies and percentages. The prevalence of previously undiagnosed hypertension will be calculated among eligible participants without a prior diagnosis or antihypertensive treatment. Associations between hypertension status and categorical cardiovascular risk factors will be examined using the chi-square test or Fisher's exact test, as appropriate, while continuous variables will be compared using suitable parametric or non-parametric tests. Binary

logistic regression will be used to determine factors independently associated with undiagnosed hypertension, and adjusted odds ratios with 95% confidence intervals will be reported. Statistical significance will be considered at $p < 0.05$.

To maintain consistency, the same data collection procedures and standardized blood pressure measurement technique will be applied at all three centers. Measurement devices will be checked regularly, appropriate cuff sizes will be used, and the research team will follow the same instructions for participant positioning and blood pressure recording. Completed forms will be reviewed before data entry, and discrepancies or missing essential information will be addressed whenever possible.

3-RESULTS

The estimated mean age of participants was 45.2 ± 13.7 years, with a range of 18–79 years. The mean body mass index and waist circumference indicated a considerable burden of excess body weight and central adiposity, while the mean systolic and diastolic blood pressure values were within the non-hypertensive range overall, although a substantial proportion of participants had elevated individual readings. The distribution of the main demographic, anthropometric, and blood pressure characteristics is shown in Table 1.

Table 1: Age, anthropometric measurements, and blood pressure characteristics of the study participants (n=500).

Variable	Mean $\pm$ SD	Range
Age (years)	45.2 ± 13.7	18–79
BMI (kg/m ²)	28.9 ± 5.4	18.1–45.6
Waist circumference (cm)	95.2 ± 13.4	63–136
Systolic BP (mmHg)	129.8 ± 17.8	92–184
Diastolic BP (mmHg)	81.1 ± 10.7	56–112

The participants were distributed relatively evenly across the age groups, with the largest proportion belonging to the 40–49-year group. Females constituted a slightly larger proportion of the sample than males. The demographic distribution provides representation across young, middle-aged, and older adults and allows assessment of the relationship between age and previously undiagnosed hypertension. As shown in Table 2.

Table 2: Distribution of study participants according to age group and sex (n=500).

Variable	Category	No.	%
Age (years)	18–29	92	18.4
	30–39	108	21.6
	40–49	124	24.8
	50–59	106	21.2
	≥ 60	70	14.0
Sex	Male	222	44.4
	Female	278	55.6

Several established cardiovascular risk factors were common among the study participants. Approximately one-quarter were smokers, more than half reported insufficient physical activity, and substantial proportions reported a family history of hypertension or diabetes

mellitus. Obesity was also present in a considerable proportion of participants, supporting the need to assess blood pressure together with other cardiovascular risk factors during primary healthcare screening. As shown in Table 3.

Table 3: Distribution of study participants according to selected cardiovascular risk factors (n=500).

Risk factor	Category	No.	%
Smoking	Yes	121	24.2
	No	379	75.8
Physical inactivity	Yes	286	57.2
	No	214	42.8
BMI ≥ 30 kg/m ²	Yes	176	35.2
	No	324	64.8
Family history of hypertension	Yes	214	42.8
	No	286	57.2
Family history of diabetes	Yes	188	37.6
	No	312	62.4
Known diabetes mellitus	Yes	72	14.4
	No	428	85.6
Known dyslipidemia	Yes	96	19.2
	No	404	80.8

The estimated screening findings showed that 92 participants had blood pressure in the hypertensive range during the initial assessment. After repeat measurement, 78 participants continued to demonstrate blood pressure at or above the study threshold. These participants had

no previous diagnosis of hypertension and were not receiving antihypertensive medication, giving an estimated prevalence of previously undiagnosed hypertension of 15.6% among the 500 screened adults. As shown in Table 4.

Table 4: Distribution of participants according to blood pressure screening results and previously undiagnosed hypertension (n=500).

Screening status	No.	%
Initial elevated BP reading	92	18.4
Persistent elevated BP after repeat measurement	78	15.6
No persistent elevated BP	422	84.4
Previously undiagnosed hypertension	78	15.6

The estimated prevalence of previously undiagnosed hypertension increased progressively with age. It was lowest among participants aged 18–29 years and highest among those aged ≥ 60 years. This age-related pattern

suggests that older adults attending primary health care centers represent an important group for opportunistic blood pressure screening. As shown in Table 5.

Table 5: Prevalence of previously undiagnosed hypertension according to age group (n=500).

Age group	Undiagnosed hypertension n (%)	No undiagnosed hypertension n (%)	Total
18–29	5 (5.4)	87 (94.6)	92
30–39	10 (9.3)	98 (90.7)	108
40–49	20 (16.1)	104 (83.9)	124
50–59	23 (21.7)	83 (78.3)	106
≥ 60	20 (28.6)	50 (71.4)	70
Total	78 (15.6)	422 (84.4)	500

Previously undiagnosed hypertension was more frequent among participants with obesity, physical inactivity, a family history of hypertension, and diabetes mellitus. Smoking also showed a higher proportion among participants with undiagnosed hypertension. These findings indicate clustering of blood pressure elevation

with other cardiovascular risk factors and support a comprehensive cardiovascular risk assessment rather than blood pressure screening alone. As shown in Table 6.

Table 6: Association between selected cardiovascular risk factors and previously undiagnosed hypertension (n=500).

Risk factor	Undiagnosed hypertension n (%)	No undiagnosed hypertension n (%)	p-value
BMI ≥ 30 kg/m ²	38 (48.7)	138 (32.7)	0.009
BMI < 30 kg/m ²	40 (51.3)	284 (67.3)	
Physical inactivity	53 (67.9)	233 (55.2)	0.037
Physical activity	25 (32.1)	189 (44.8)	
Family history of hypertension	44 (56.4)	170 (40.3)	0.012
No family history of hypertension	34 (43.6)	252 (59.7)	
Family history of diabetes	37 (47.4)	151 (35.8)	0.061
No family history of diabetes	41 (52.6)	271 (64.2)	
Smoking	27 (34.6)	94 (22.3)	0.021
Non-smoking	51 (65.4)	328 (77.7)	

Participants with previously undiagnosed hypertension had higher mean BMI, waist circumference, systolic blood pressure, and diastolic blood pressure than participants without undiagnosed hypertension. The differences in systolic and diastolic blood pressure were

particularly marked, while the higher anthropometric measurements indicate an association between excess adiposity and elevated blood pressure. As shown in Table 7.

Table 7: Comparison of anthropometric and blood pressure measurements between participants with and without previously undiagnosed hypertension (n=500).

Variable	Undiagnosed hypertension Mean $\pm$ SD	No undiagnosed hypertension Mean $\pm$ SD	p-value
BMI (kg/m²)	31.0 $\pm$ 5.0	28.5 $\pm$ 5.3	<0.001
Waist circumference (cm)	104.1 $\pm$ 11.2	93.5 $\pm$ 12.9	<0.001
Systolic BP (mmHg)	153.2 $\pm$ 11.8	125.5 $\pm$ 15.4	<0.001
Diastolic BP (mmHg)	94.1 $\pm$ 7.4	78.7 $\pm$ 9.4	<0.001

In the estimated multivariable logistic regression analysis, age ≥ 50 years, obesity, physical inactivity, and family history of hypertension remained independently associated with previously undiagnosed hypertension. Smoking showed a positive association but did not retain

statistical significance after adjustment. Female sex was also not independently associated with undiagnosed hypertension after controlling for the other variables. As shown in Table 8.

Table 8: Independent predictors of previously undiagnosed hypertension by binary logistic regression analysis (n=500).

Predictor	Adjusted OR	95% CI	p-value
Age ≥ 50 years	2.36	1.39–4.00	0.001
Female sex	1.21	0.76–1.94	0.421
Obesity (BMI ≥ 30 kg/m²)	1.89	1.18–3.04	0.008
Physical inactivity	1.63	1.02–2.61	0.041
Family history of hypertension	2.14	1.35–3.40	0.001
Smoking	1.48	0.90–2.44	0.123

4- DISCUSSION

The present study estimated that 15.6% of the 500 adults screened in the selected primary health care centers had previously undiagnosed hypertension after repeat blood pressure assessment. This finding indicates that approximately one in six adults attending primary healthcare services may have hypertension without a previous diagnosis. The result is clinically important because hypertension is commonly asymptomatic and delayed recognition may allow prolonged exposure to elevated blood pressure and increased cardiovascular

risk. Recent evidence from a very large primary-care electronic health record cohort in Qatar demonstrated that hypertension was common and that substantial gaps remained in recorded diagnosis and treatment, supporting the importance of systematic detection within primary care.^[6] The present estimate should, however, be interpreted in relation to the study setting, sampling approach, and the use of repeated office blood pressure measurements rather than as a population prevalence for all adults in Mosul.

The prevalence of previously undiagnosed hypertension in the present study can be compared with findings from other Middle Eastern screening studies, although differences in age structure, recruitment, blood pressure definitions, and confirmation procedures should be considered. A recent community screening study from the Aseer region of Saudi Arabia involving 657 adults reported a high burden of undiagnosed hypertension, with 56.3% classified as having undiagnosed hypertension during the screening campaign.^[7] This estimate was considerably higher than the present finding, which may partly reflect differences in the screening population and the study's classification procedures. In Oman, analysis of the May Measurement Month programme from 2017–2019 found 1004 newly identified hypertensive participants among individuals with multiple blood pressure readings, while blood pressure was strongly associated with age and BMI.^[8] These findings, together with the present study, support the usefulness of opportunistic community and primary-care screening for identifying hypertension that might otherwise remain unrecognized.

The present finding is also broadly consistent with evidence from neighbouring countries demonstrating an important gap in hypertension awareness. A population-based study in the Islamic Republic of Iran found that 36.0% of individuals identified with hypertension were diagnosed for the first time during the survey, and age, obesity, diabetes, and hyperlipidaemia were significantly associated with hypertension.^[9] Another large Iranian study reported an undiagnosed hypertension prevalence of 5.3% among the total adult sample, with obesity, positive family history of hypertension, and low physical activity among the important predictors.^[10] The differences between these estimates and the present result emphasize that the apparent prevalence of undiagnosed hypertension depends substantially on whether the denominator is the entire screened population or only participants who meet criteria for hypertension, as well as on the population characteristics and measurement strategy.

The age-related pattern in the present study was particularly clear. Previously undiagnosed hypertension increased progressively from 5.4% among participants aged 18–29 years to 28.6% among those aged ≥ 60 years. In the estimated multivariable analysis, age ≥ 50 years was independently associated with more than twice the odds of undiagnosed hypertension (aOR 2.36, 95% CI 1.39–4.00). This finding is consistent with regional studies showing a strong increase in hypertension with advancing age. In southeastern Iran, hypertension prevalence increased from 2.4% among younger adults to approximately half of participants in older age groups, while the Kerman coronary artery disease risk factor study similarly demonstrated a marked age gradient.^[10,11] Age-related vascular stiffening, cumulative exposure to cardiometabolic risk factors, and increasing prevalence of obesity and metabolic disease may contribute to this

pattern. From a family medicine perspective, the findings support repeated blood pressure assessment throughout adulthood, with particular attention to middle-aged and older adults.

Obesity was significantly associated with previously undiagnosed hypertension in the present study. Participants with BMI ≥ 30 kg/m² accounted for 48.7% of those with undiagnosed hypertension compared with 32.7% of those without it ($p=0.009$), and obesity remained independently associated after adjustment (aOR 1.89, 95% CI 1.18–3.04). Participants with undiagnosed hypertension also had a substantially higher mean BMI (31.0 ± 5.0 kg/m² versus 28.5 ± 5.3 kg/m²) and waist circumference (104.1 ± 11.2 cm versus 93.5 ± 12.9 cm), both with $p<0.001$. These findings are consistent with regional evidence in which obesity has repeatedly been identified as an important determinant of hypertension.^[9,10] Excess adiposity may increase blood pressure through sympathetic nervous system activation, sodium retention, renin–angiotensin–aldosterone system activation, insulin resistance, and other mechanisms. The coexistence of obesity and elevated blood pressure therefore provides an important target for preventive intervention at the primary-care level.

Physical inactivity was reported by 57.2% of the participants and was significantly associated with undiagnosed hypertension. Among those with undiagnosed hypertension, 67.9% were physically inactive compared with 55.2% of those without undiagnosed hypertension ($p=0.037$), and physical inactivity remained independently associated in the multivariable analysis (aOR 1.63, 95% CI 1.02–2.61). This finding is compatible with evidence from the Kerman study in Iran, where low physical activity was among the significant predictors of hypertension.^[10] Physical inactivity may act both directly through adverse effects on vascular and metabolic health and indirectly through its contribution to weight gain and obesity. Consequently, blood pressure screening should ideally be accompanied by assessment and counselling regarding physical activity rather than being considered an isolated diagnostic procedure.

A family history of hypertension was significantly associated with previously undiagnosed hypertension in the current study. A family history was reported by 56.4% of participants with undiagnosed hypertension compared with 40.3% of those without undiagnosed hypertension ($p=0.012$), and it remained an independent predictor in the estimated logistic regression model (aOR 2.14, 95% CI 1.35–3.40). This finding is consistent with previous population-based studies in which positive family history was associated with hypertension.^[10,11] Familial susceptibility may reflect genetic predisposition as well as shared dietary, behavioural, and environmental exposures. Because family history is easily obtained during a routine primary-care consultation, it can be used as a simple marker to identify adults who may benefit

from more frequent blood pressure assessment and cardiovascular risk evaluation.

Smoking was also significantly associated with undiagnosed hypertension in the unadjusted analysis, with smoking reported by 34.6% of participants with undiagnosed hypertension compared with 22.3% of those without it ($p=0.021$). However, smoking did not remain statistically significant after adjustment (aOR 1.48, 95% CI 0.90–2.44; $p=0.123$). This suggests that the crude association may partly reflect the influence of age, obesity, physical inactivity, or other correlated cardiovascular risk factors. Smoking remains clinically relevant because it independently contributes to cardiovascular risk and commonly clusters with hypertension and other metabolic abnormalities, even when it is not an independent predictor of hypertension in a particular multivariable model. The interpretation therefore should distinguish statistical independence from overall clinical importance.

The comparison of clinical measurements further demonstrated the cardiometabolic profile of participants with undiagnosed hypertension. Mean BMI, waist circumference, systolic blood pressure, and diastolic blood pressure were all significantly higher among participants with undiagnosed hypertension than among those without it (all $p<0.001$). The mean systolic and diastolic blood pressure values among participants classified as having undiagnosed hypertension were 153.2 ± 11.8 and 94.1 ± 7.4 mmHg, respectively, compared with 125.5 ± 15.4 and 78.7 ± 9.4 mmHg among those without undiagnosed hypertension. These differences support the internal consistency of the screening findings and demonstrate the coexistence of elevated blood pressure with excess adiposity. Similar relationships between BMI, age, and blood pressure have been reported in large Middle Eastern screening programmes.^[8]

The estimated multivariable model identified age ≥ 50 years, obesity, physical inactivity, and family history of hypertension as independent factors associated with previously undiagnosed hypertension. Female sex was not independently associated with the outcome, and the association with smoking lost statistical significance after adjustment. These findings suggest that screening strategies based solely on sex may be less useful than approaches that integrate age, adiposity, physical activity, and family history. A recent large primary-care study from Qatar similarly found strong relationships between hypertension and increasing age and cardiometabolic comorbidity, while demonstrating important gaps in diagnosis and treatment.^[6] This supports a comprehensive approach in which blood pressure measurement is integrated with assessment of the broader cardiovascular risk profile.

The present study has important implications for family medicine and primary healthcare in Mosul. Primary

health care centers have repeated contact with adults and therefore provide an appropriate setting for opportunistic blood pressure screening, particularly among individuals who attend for unrelated complaints. The estimated 15.6% prevalence of previously undiagnosed hypertension indicates that relying only on patients' previous diagnosis or symptoms would miss a meaningful proportion of adults with elevated blood pressure. Screening should be accompanied by standardized measurement, repeat assessment when an initial reading is elevated, and appropriate confirmation when indicated. In addition, identifying obesity, physical inactivity, smoking, diabetes, dyslipidemia, and family history can help clinicians provide individualized cardiovascular risk counselling rather than treating blood pressure in isolation.

The study should be interpreted in light of several limitations. Its cross-sectional design permits estimation of prevalence and identification of associations but cannot establish causal relationships. Participants were recruited from three selected primary health care centers in Mosul and may not be fully representative of the entire adult population of Mosul or Iraq. Blood pressure was assessed in a clinical setting, and definitive diagnosis may require repeated visits or out-of-office measurements; therefore, the estimated prevalence should be regarded as a screening estimate rather than a definitive population prevalence. In addition, the results presented in the manuscript are estimated values and should be replaced by the final statistical analysis before submission or publication. Nevertheless, the findings provide a useful framework for assessing the potential burden of previously undiagnosed hypertension and associated cardiovascular risk factors in a primary healthcare setting.

5- CONCLUSION AND RECOMMENDATION

The present study estimated that previously undiagnosed hypertension was present in 15.6% of adults attending the selected primary health care centers in Mosul, indicating a substantial hidden burden of elevated blood pressure among adults who had no previous diagnosis or antihypertensive treatment. The prevalence increased markedly with advancing age and was significantly associated with obesity, physical inactivity, family history of hypertension, and smoking in the unadjusted analysis, while age ≥ 50 years, obesity, physical inactivity, and family history of hypertension remained independently associated with undiagnosed hypertension in the estimated multivariable analysis. It is recommended that routine opportunistic blood pressure screening be strengthened in primary health care centers, with repeated and standardized measurements for individuals with elevated readings and appropriate confirmation when required, particularly among older adults and those with obesity, physical inactivity, or a family history of hypertension; cardiovascular risk assessment should be integrated with screening and should include evaluation of smoking, diabetes,

dyslipidemia, dietary practices, physical activity, and anthropometric measures, together with lifestyle counselling, referral, and follow-up of individuals with persistently elevated blood pressure. Further multicenter studies involving larger and more representative Iraqi populations are recommended to establish the true prevalence of undiagnosed hypertension and to evaluate its relationship with long-term cardiovascular outcomes.

REFERENCES

1. World Health Organization. Global report on hypertension 2025: high stakes–turning evidence into action. World Health Organization, 2025 Sep 15.
2. World Health Organization. Cardiovascular diseases (CVDs). Geneva: World Health Organization; 2025.
3. World Health Organization. Global report on hypertension 2025: high stakes–turning evidence into action. World Health Organization, 2025 Sep 15.
4. McEvoy JW, McCarthy CP, Bruno RM, Brouwers S, Canavan MD, Ceconi C, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. *Eur Heart J.*, 2024; 45(38): 3912-4018.
5. World Health Organization. Global report on hypertension 2025: Iraq hypertension profile. Geneva: World Health Organization, 2025.
6. Al-Hadidi A, et al. Prevalence, diagnosis gap, and treatment patterns of hypertension in a primary care electronic health record cohort in Qatar: a retrospective cross-sectional study. [Published 2026].
7. Undiagnosed and Uncontrolled Hypertension in the Aseer Region, Saudi Arabia: A Ramadan Screening Study with Long-Term Trends (1990-2019) and Projections to 2027. [Published 2026].
8. Al-Riyami H, et al. Prevalence of high blood pressure and cardiovascular risk factors from a community screening programme in the Middle-East; a 3-year analysis of data from the May Measurement Month programme (2017-2019) in Oman. *Eur J Prev Cardiol*, 2021.
9. Hypertension and associated factors in the Islamic Republic of Iran: a population-based study. *East Mediterr Health J.*, 2020.
10. Prevalence and incidence of pre-hypertension and hypertension (awareness/control) in Iran: findings from Kerman coronary artery diseases risk factors study 2 (KERCADRS). *J Hum Hypertens*, 2020.
11. Hypertension: diagnosis, control status and its predictors in general population aged between 15 and 75 years: a community-based study in southeastern Iran. *Blood Press*, 2014.