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Screening for Diabetes Mellitus and Hypertension in Duhok Governorate, Kurdistan Region of Iraq

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Abstract
Objective: To determine the prevalence and significant correlates of prediabetes (pre-DM), diabetes mellitus (DM), prehypertension (pre-HT), and hypertension (HT) among adults in all districts of Duhok Governorate through a community-based screening study.
Methods: This is a cross-sectional community-based screening study involving 3,000 non-fasting adults not diagnosed as prediabetes or DM and prehypertension or HT conducted in all districts of Duhok Governorate. Random glucose and blood pressure reading according to American Diabetes Association and American Heart Association Guidelines in 2023 will be used in a community-based screening. BMI will be also calculated in the present study as a screening tool.
Results: Findings reveal that 18.2% had DM, 14.7% had pre-DM and 41.3% had HT and 11.5% had pre-HT. The study also revealed that nearly two third had increased BMI in which 40.1% were overweight and 24.5% were obese. Among screened subjects 32% were smokers. Around half of screened subjects reported having family history of DM and HT, DM alone (10.8%), HT alone (12.1%) and 28.9% had family history of both DM and HT together. The study also shows that screened male subjects reported higher prevalence of pre-DM, DM, pre-HT and HT than screened female subjects. Older age group of screened subjects tend to have more abnormal blood sugar and blood pressure levels than younger age group.
Conclusion: This study has shown a high prevalence of pre-DM, DM, pre-HT and HT among adults in all districts of Duhok Governorate. Significant correlates of pre-DM, DM, pre-HT and HT in this study were age, gender, BMI, smoking and family history.
Keywords: Age, basal metabolic rate, diabetes mellitus, gender, hypertension, smoking

Introduction

Diabetes Mellitus (DM) and Hypertension (HT) are the most common public health problems and most common causes of death worldwide.[1] In 2021, the global estimated prevalence of DM was 536.6 million people which is expected to be projected to 783.2 million people in 2045 (Sun et al., 2021) while the estimated prevalence of HT is more than 1 billion in 2019 and expected to rise to more than 3.5 billion people with non-optimal blood pressure in 2018.[2–4]

In 2016, more than half of all mortality in Iraq was attributable to non-communicable diseases (NCDs).[5] DM and HT are among the two most types of NCDs and both can lead to many complications. In Iraq, according the report released by the Ministry of Health, it is estimated that 14% of Iraqis have DM (WHO, 2023) which mean that expected diabetic patients are 6,020,000 as a 14% of total 43 million estimated population of Iraq and T1DM are 301,100 as a 5% of all DM cases.[6] In Kurdistan Region of Iraq, with an estimated population of 6,200,000 in 2023, the expected diabetic cases are 868,000. However, out of 868,000 cases only 117,680 cases were registered in 2022 (Erbil: 48,967 Sulaimaniyah: 36,000 Duhok: 32,713) and around 750,320 diabetic patients are either not diagnosed or unaware of having DM or receiving treatment in private sector.

The prevalence of HT is always underestimated and the screening of high blood pressure through clinical or routine examination or after the development of cardiovascular complications. The estimated prevalence of HT in Iraq is around 40% according to World Health Organization in 2013. The prevalence of overweight and obesity in Iraq is 31.8% and 33.9%, respectively.

Therefore, the present study aims to identify the DM and HT prevalence in the adult population and is designed to screen blood sugar and blood pressure and their correlation to basal metabolic rate (BMI) in Duhok Governorate, Kurdistan Region of Iraq and advocate for a policy to implement an effective screening measures in regard to blood sugar, blood pressure and weight.

Methods

This is a cross-sectional community-based screening study involving 3,000 non-fasting adults not diagnosed as prediabetes or DM and prehypertension or HT conducted during the World Diabetes Day on 14th November, 2023 in all districts of Duhok Governorate (Duhok, Zakho, Sumel, Amedy, Akre, Bardarash and Shekhan). Random glucose and blood pressure will be used in a community-based screening to assemble the random glucose and blood pressure. BMI will be also calculated in the present study as a screening tool used to identify individuals who have underweight, healthy weight, overweight, or obesity. Inclusion criteria is all non-diabetic and non-hypertensive adults more than 20 years old regardless of past medical history of other diseases while exclusion criteria include age less than 20 years old and already diagnosed DM and hypertensive patients.

American Diabetes Association (2023) screening strategies and predict DM using random blood sugar testing and classified as prediabetes when random blood sugar is 140 to 199 mg/dl or DM when random blood sugar is more than 200 mg/dl while random reading less than 140 mg/dl considered normal.[7] American Heart Association (2023) classification of abnormal blood pressure as a prehypertension when systolic 120-139 mm Hg, diastolic 80-89 mmHg and HT when

systolic more than 140 mm Hg, more than diastolic 90 mm Hg while blood pressure is considered normal when systolic lower than 120 mm Hg, diastolic lower than 80 mm Hg. Center for Disease Control and Prevention (2023) classify BMI as underweight (18.5), healthy (18.5–14.9), overweight (25–29.9) or obese (30 and above). The rate is a calculated measure of weight relative to height, defined as body weight in kilograms divided by height in meters squared.[8]

Nurse coordinators of NCDs Program in Primary Healthcare Center in different districts and graduates from College of Health and Medical Technology, Duhok Polytechnic University will be trained to screen for DM and HT under supervision NCD Department at Duhok Preventive Health Directorate. Blood pressure will be measured with a standard zero mercury sphygmomanometer and a standard cuff (12 × 34 cm) and auscultation method, the person will be seated peacefully and will be checked for blood pressure with feet on the floor and an arm support at the level of the heart. While the random blood sugar will be taken by using a glucometer using electrochemical technology and electrochemical test strips. Sphygmomanometer and glucometer were supplied by the Duhok Preventive Health Directorate. Participants will be also asked about the past medical and family history, and smoking history. Before conducting screening of blood sugar and blood pressure, hospitals will be notified about the aim of the study and the confidentiality of data will ensure by the researcher also their rights to refuse or participate in the present study will confirm. Moreover, health education leaflets (in Arabic and Kurdish languages) and visual roll-ups on prevention and management of DM and HT will be distributed and displayed for the purpose of health promotion. All participants with abnormal blood sugar and/or blood pressure will be tested again to confirm a diagnosis and those with abnormal readings will be referred to primary health care centers and hospitals for the purpose of registration and follow-up. For ethical considerations, this study research protocol will be submitted for the approval by the Ethical Committee from the concerned health sectors in Kurdistan Region, namely, the Duhok Directorate General of Health and Scientific Committee at College of Medicine, University of Duhok. Formal permission was taken from the provincial authority in Duhok. The data is quantitative in nature and statistical analysis of the collected data coded were appropriately analyzed by SPSS 20.0 version (Statistical Package for Social Science), data was analyzed and interpreted by descriptive (frequency, percentage, mean, standard deviation) and inferential (chi-squared test) statistics to determine the association between DM and HT to sample characteristics.

Results

The studies sample included 3,000 screened adults from all districts of Duhok Governorate (Duhok, Zakho, Sumel, Amedy, Akre, Bardarash and Shekhan). The obtained data were analyzed, interpreted and presented as clinical characteristics and demographic variables of screened subjects, and measurements and prevalence of blood sugar and blood pressure. The sample comprised of 2133 (71.1%) males and 867 (28.9%) females. The mean ± SD of age was 44.67 ± 13.38 years. The minimum age of was 20 years, and the maximum age was 85 years, the mostly screened subjects (46.2%) were in the middle age group 40–59 years.

Among these around one third had abnormal blood sugar, were 14.7% had pre-DM and 18.2% had DM. Almost half (52.8%) of the screened subjects had abnormal blood pressure were 11.5% had pre-HT and 41.3% had HT.

Around two third (64.6%) had increased body weight, were 40.1% had overweight and 24.5% had obesity. Among these subjects, one third were non-smokers while 32% were smokers and 2.6% were ex-smokers, furthermore, around 49.6% of smokers were smoking for 16–30 years.

Around half of screened subjects had no family history of DM and HT, only 10.8% had family history of DM alone, 12.1% had family history of HT alone and 28.9% had family history of both DM and HT together. Majority of screened subjects (86.8%) had no past medical history while the remaining had history of cardiovascular diseases (CVD), chronic kidney diseases (CKD), cancer and etc. (Table 1).

Table 1. **Characteristics of the study sample**

Characteristic		No.	%
Gender	Male	2133	71.1
	Female	867	28.9
Age (years)	20–39	1137	37.9
	40–59	1385	46.2
	60–85	478	15.9
Measurements of random blood sugar (prevalence)	Normal individuals	2013	67.1
	Pre-DM	440	14.7
	DM	547	18.2
Measurements of random blood pressure (prevalence)	Normal individuals	1416	47.2
	Pre-HT	346	11.5
	HT	1238	41.3
BMI	Underweight	50	1.7
	Normal	1011	33.7
	Overweight	1203	40.1
	Obese	736	24.5
Smoking	Smoker	959	32.0
	Non-smoker	1964	65.5
	Ex-smoker	77	2.6
Duration of smoking (years)*	1–15	373	38.9
	16–30	476	49.6
	> 30	110	11.5
Family history of DM, HT	DM	324	10.8
	HT	362	12.1
	Both DM and HT	867	28.9
	None	1446	48.2
Past medical history	CVD	299	10.0
	CKD	16	0.5
	Cancer	6	0.2
	Respiratory disease	12	0.4
	Others	64	2.1
	None	2603	86.8
Total		3000	100.0

*Only for smokers.

In reference to DM relation to demographic and clinical characteristics of screened subjects, 65.9% of males and 70.1% of females had normal blood sugar levels while 34.1% of males and 29.8% of females had abnormal blood sugar. In which, males who had pre-DM and DM were 15.6% and 18.5% consecutively, while females who had pre-DM and DM were 12.3% and 17.5% consecutively, ($P = 0.039$), as shown in Table 2.

Majority of screened subject in the 20–39 years old category had normal blood sugar (82.1%), while 61.2% of those in the 40–59 years old category had normal blood sugar and 48.5% of those in the 60–85 years old had normal blood sugar. Around 17.9% of those aged 20–39 years old had abnormal blood sugar (11.4% had pre-DM and 6.5% had DM), about 38.7% of those aged 40–59 years old had abnormal blood sugar (15.2 had pre-DM and 23.5% had DM), meanwhile 51.5% of those aged 60–85 years old had abnormal blood sugar (20.7% had pre-DM and 30.8% had DM), ($P < 0.001$), as shown in Table 2.

Around one third of obese screened subject had abnormal blood sugar (13.6% were pre-DM and 22.8% were DM), another one third were overweight (17.5% were pre-DM and 19.8% were DM) whereas 12.3% of pre-DM subjects and 13.4% of DM subjects had normal BMI and 10% of pre-DM and 12% of DM were underweight, ($P < 0.001$). Pre-DM smoker subjects were 16.3% and DM smoker subjects were 17.5%, the remaining subjects were either non-smoker or ex-smoker, ($P = 0.034$), as shown in Table 2.

Pre-DM screened subjects with family history of DM were 19.4% and DM screened subjects with family history of DM were 22.8% while pre-DM screened subjects with family history of both DM and HT were 16.1% and DM screened subjects with family history of both DM and HT were 29.6%, ($P < 0.001$). More than two third of screened subjects had no past medical history while one third had CVD, CKD, cancer and respiratory diseases,($P < 0.001$), as shown in Table 2.

In reference to HT relation to demographic and clinical characteristics of screened subjects, 44.8% of males and 53.2% of females had normal blood pressure while 55.2% of males and 46.8% of females had abnormal blood pressure. In which, males who had pre-HT and HT were 11.9% and 43.3% consecutively, while females who had pre-HT and HT were 10.6% and 36.2% consecutively, $P < 0.001$, as shown in Table 3.

Most of screened subject in the 20–39 years old category had normal blood pressure (64.8%), while 40.7% of those in the 40–59 years old category had normal blood pressure and 24.1% of those in the 60–85 years old had normal blood pressure. Around 35.2% of those aged 20–39 years old had abnormal blood pressure (11.1% had pre-HT and 24.1% had HT), about 59.3% of those aged 40–59 years old had abnormal blood pressure (12.3% had pre-HT and 40% had HT), meanwhile 76% of those aged 60–85 years old had abnormal blood

Table 2. **Relationship of measurement of RBS with demographic and clinical characteristics**

Characteristic		Measurement of RBS							*P* value
		Normal		Pre-DM		DM		Total	
		No.	%	No.	%	No.	%	No.	
Gender	Male	1405	65.9	333	15.6	395	18.5	2133	0.039
	Female	608	70.1	107	12.3	152	17.5	867	
Age (years)	20–39	933	82.1	130	11.4	74	6.5	1137	
	40–59	848	61.2	211	15.2	326	23.5	1385	< 0.001
	60–85	232	48.5	99	20.7	147	30.8	478	
BMI groups	Underweight	39	78.0	5	10.0	6	12.0	50	
	Normal	752	74.4	124	12.3	135	13.4	1011	< 0.001
	Overweight	754	62.7	211	17.5	238	19.8	1203	
	Obese	468	63.6	100	13.6	168	22.8	736	
Smoking	Smoker	635	66.2	156	16.3	168	17.5	959	
	Nonsmoker	1333	67.9	265	13.5	366	18.6	1964	0.034
	Ex-smoker	45	58.4	19	24.7	13	16.9	77	
Family history of DM, HT	DM	187	57.7	63	19.4	74	22.8	324	
	HT	282	77.9	47	13.0	33	9.1	362	< 0.001
	Both DM and HT	470	54.2	140	16.1	257	29.6	867	
	None	1074	74.3	190	13.1	182	12.6	1446	
Past medical history	CVD	113	37.8	54	18.1	132	44.1	299	
	CKD	9	56.3	4	25.0	3	18.8	16	
	Cancer	1	16.7	0	.0	5	83.3	6	< 0.001
	Respiratory disease	6	50.0	3	25.0	3	25.0	12	
	Others	36	56.3	13	20.3	15	23.4	64	
	None	1848	71.0	366	14.1	389	14.9	2603	
Total		2013	67.1	440	14.7	547	18.2	3000	

Table 3. **Relationship of measurement of HT with demographic and clinical characteristics**

Characteristics		Measurement of HT							*P* value
		Normal		Pre-HT		HT		Total	
		No.	%	No.	%	No.	%	No.	
Gender	Male	955	44.8	254	11.9	924	43.3	2133	< 0.001
	Female	461	53.2	92	10.6	314	36.2	867	
Age (years)	20–39	737	64.8	126	11.1	274	24.1	1137	
	40–59	564	40.7	170	12.3	651	47.0	1385	< 0.001
	60–85	115	24.1	50	10.5	313	65.5	478	
BMI groups	Underweight	36	72.0	7	14.0	7	14.0	50	
	Normal	543	53.7	121	12.0	347	34.3	1011	< 0.001
	Overweight	565	47.0	147	12.2	491	40.8	1203	
	Obese	272	37.0	71	9.6	393	53.4	736	
Smoking	Smoker	451	47.0	116	12.1	392	40.9	959	
	Nonsmoker	939	47.8	219	11.2	806	41.0	1964	0.177
	Ex-smoker	26	33.8	11	14.3	40	51.9	77	
Family history of DM, HT	DM	206	63.6	37	11.4	81	25.0	324	
	HT	124	34.3	51	14.1	187	51.7	362	< 0.001
	Both DM and HT	313	36.1	93	10.7	461	53.2	867	
	None	773	53.5	165	11.4	508	35.1	1446	
Past medical history	CVD	77	25.8	39	13.0	183	61.2	299	
	CKD	7	43.8	2	12.5	7	43.8	16	
	Cancer	1	16.7	1	16.7	4	66.7	6	< 0.001
	Respiratory disease	7	58.3	1	8.3	4	33.3	12	
	Others	21	32.8	7	10.9	36	56.3	64	
	None	1303	50.1	296	11.4	1004	38.6	2603	
Total		1416	47.2	346	11.5	1238	41.3	3000	

pressure (10.5% had pre-HT and 65.5% had HT), $P < 0.001$, as shown in Table 3.

Nearly two third of obese screened subject had abnormal blood pressure (9.6% were pre-HT and 53.4% were HT), around half of screened subjects were overweight (12.2% were pre-HT and 40.8% were HT) whereas 12% of pre-HT subjects and 34.3% of HT subjects had normal BMI and 14% of pre-HT and 14% of HT were underweight, ($P < 0.001$), as shown in Table 3. Pre-HT smoker subjects were 12.1% and HT smoker subjects were 40.9%, the remaining subjects were either non-smoker or ex-smoker.

Pre-HT screened subjects with family history of HT were 14.1% and HT screened subjects with family history of HT were 51.7% while pre-HT screened subjects with family history of both DM and HT were 10.7% and HT screened subjects with family history of both DM and HT were 53.2%. Around half of screened subjects had no past medical history (Table 3).

Discussion

This is a cross-sectional community-based screening study that aims to determine the prevalence of prediabetes or DM and prehypertension or HT among 3,000 non-fasting subjects aged more than 20 years who are not diabetic (or prediabetic) or hypertensive (or prehypertensive).

Findings reveal that 18.2% had DM. A local study in Iraq reported a 19.7% as a prevalence of diabetes in subjects aged 19 to 94 years.[9] This finding is close to the results of the current study. Though, the fact that there is insufficient epidemiological research in Iraq related to DM should be highlighted.[10]

Regarding hypertension prevalence, the present study shows that 41.3% had HT. Data involving a sample of 4120 Iraqi adult derived from Non-Communicable Diseases Risk Factors STEPS survey Iraq 2016 concluded the prevalence of hypertension as a 35.6%.[11] The findings of the current study are markedly higher than the previously reported studies by Abdul Hasan et al. (2021) which was 24%.[12]

The current study also concluded that 14.7% had pre-DM and 11.5% had pre-HT. Plenty of studies refer to the increased prevalence of pre-DM and pre-HT. A study concluded prevalence of prediabetes among healthy Iraqi individuals to be 17% (Jasim et al., 2022), and another study concluded the prevalence of pre-hypertension to be 26.21%.[13,14]

Based upon aforementioned findings of the present study, around 32.9% had abnormal blood sugar and 52.8% had abnormal blood pressure which is conclusive with the findings by Uthman et al. (2022) involving 108110 subjects in 62 studies on global prevalence and trends of type 2 diabetes and hypertension in slum populations ranged from 0.9% to 25.0% and 4.2% to 52.5%, respectively.[15]

Our study also revealed that nearly two third had increased BMI in which 40.1% were overweight and 24.5% were obese. This is conclusive with the findings that link increased weight to development of DM (Yashi and Daley, 2023) and hypertension.[16,17] Being overweight or obese explain the increase in the resistance cells to insulin as well as resistance in the blood vessels.

Among screened subjects 32% were smokers. U.S. Department of Health and Human Services (2014) denote to the fact smoking especially tobacco makes managing diabetes more difficult and the fact that Virdis et al. (2010) focused on that smokers are more likely to develop severe forms of hypertension.[18,19]

Around half of screened subjects reported having family history of DM and HT, 10.8% had family history of DM alone, 12.1% had family history of HT alone and 28.9% had family history of both DM and HT together. Abdulaziz et al. (2023) refers to existing evidence that family history influences the risk of developing DM, in the same manner Ranasinghe et al. (2015) refers to the fact that hypertension was significantly higher in those with a family history of hypertension.[20,21]

Current study shows that screened male subjects reported higher prevalence of pre-DM and DM than screened female subjects, the findings were 15.6% for pre-DM and 18.5% for DM in male compare to 12.3% for pre-DM and 17.5% for DM in females. A study by Nordström et al. (2016) showed a higher prevalence of DM among men compared to women and referred to association with large amount of visceral fat in men.[22] This is similar to finding of our study where high BMI levels were reported among pre-DM and DM screened subjects.

Regarding age group of pre-DM and DM in this study, older age group of screened subjects tend to have more abnormal blood sugar levels than younger age group where 51.5% of those aged 60–85 years had abnormal blood sugar (20.7% had pre-DM and 30.8% had DM) compare to 38.7% of those aged 40–59 years (15.2% had pre-DM and 23.5% had DM) and the least were reported among youngest age group of this study were 17.9% of those aged 20–39 years old had abnormal blood sugar (11.4% had pre-DM and 6.5% had DM). Sharma and Thapa (2022) found that age is significantly associated with diabetes prevalence.[1] Similar finding reported by Yan et al. (2023) where advanced age has been highlighted as a major risk factor for developing DM and pre-DM with a more likelihood to develop microvascular and macrovascular complications.[23]

Current study also shows that screened male subjects reported higher prevalence of pre-HT and HT than screened female subjects, the findings were 11.9% for pre-HT and 43.3% for HT in male compare to 10.6% for pre-HT and 36.2% for HT in females. A study by Agho et al. (2018) showed a higher prevalence of pre-HT and HT among men compared to women.[24] Al-Raddadi et al. (2021) referred to this gender difference through association to lifestyle practices.[25]

Regarding age group of pre-HT and HT in this study, older age group of screened subjects tend to have more abnormal blood pressure levels than younger age group where 76% of those aged 60–85 years had abnormal blood pressure (10.5% had pre-HT and 65.5% had HT) compare to 59.3% of those aged 40–59 years (12.3% had pre-HT and 40% had HT) and the least were reported among youngest age group of this study were 35.2% of those aged 20–39 years old had abnormal blood pressure (11.1% had pre-HT and 24.1% had HT). Yu et al. (2020) found that age is associated with HT prevalence especially among middle-aged and elderly and confirmed this relationship of progression from prehypertension to hypertension in men and women, as a 1-year increase in age was associated with a 1.05-fold increase in the risk.[26]

Screened obese and overweight subject reported higher prevalence of pre-HT and HT, i.e. nearly two third of obese screened subject (9.6% were pre-HT and 53.4% were HT), around half of overweight screened subjects (12.2% were pre-HT and 40.8% were HT). Sun et al. (2021) denoted to this established relationship that increased BMI alone was significantly associated with HT in different age group.[27]

In conclusion, this study has shown a high prevalence of pre-DM, DM, pre-HT and HT among adults in all districts of Duhok Governorate, Iraq. Nearly two out of ten adult was diabetic, three out of twenty adult were pre-diabetic, four out of ten adult were hypertensive, two out of twenty adult were pre-hypertensive. Significant correlates of pre-DM, DM, pre-HT and HT in this study were age, gender, BMI, smoking and family history. The unprecedented high numbers of pre-DM, DM, pre-HT and HT among adults urges health authorities, policymakers, and public health practitioners for an urgent preventive and screening programs to reduce pre-DM and pre-HT before it develops to DM and HT, thereby reducing the risk of cardiovascular and cerebrovascular diseases which are the leading causes of death in the community as well as reducing the financial burden on the government and improve the overall wellbeing of community individuals and families. Data generated in this study can be of great benefits for further research in understanding modifiable and non-modifiable factors and designing interventions to improve awareness, prevention, screening, treatment and control of blood sugar and blood pressure.

Conflict of Interest

The authors declare no conflict of interest.

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