ОЖИРЕНИЕ И АРТЕРИАЛЬНАЯ ГИПЕРТЕНЗИЯ ПРИ САХАРНОМ ДИАБЕТЕ 2 ТИПА У ЖИТЕЛЕЙ ЙЕМЕНА: РАСПРОСТРАНЕННОСТЬ И СОЦИАЛЬНО-ДЕМОГРАФИЧЕСКИЕ ФАКТОРЫ РИСКА

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ОБОСНОВАНИЕ. Сахарный диабет (СД) — это быстро прогрессирующая и сложная проблема здравоохранения XXI в. СД 2 типа (СД2) является основным фактором риска ожирения и артериальной гипертензии (АГ). Задокументированных сведений о распространенности АГ и ожирения у пациентов с СД2 в Йемене недостаточно.
ЦЕЛЬ. Оценка распространенности АГ и ожирения у пациентов с СД2 в Йемене.
МАТЕРИАЛЫ И МЕТОДЫ. Поперечное исследование было проведено в больницах города Дхамар. Были обследованы 300 мужчин и женщин в возрасте 30 лет и старше с диагнозом СД2, впервые обратившихся в клинику эндокринологии и диабета городской больницы г. Дхамара: оценены уровень глюкозы в крови, режим лечения, продолжительность заболевания и индекс массы тела (ИМТ). Социально-демографические и клинические данные были собраны с помощью предварительно протестированных анкет. Исследование было одобрено на заседаниях соответствующих этических комитетов Университета Дхамара и больниц. Данные были проанализированы с использованием SPSS, версия 23.
РЕЗУЛЬТАТЫ. Распространенность избыточной массы тела и/или ожирения при СД2 составила 60,67%, АГ — 35,66%. По частоте встречаемости СД2 преобладали женщины (56,33%), больные в возрасте старше 50 лет (61%), а также жители сельской местности (74%). Сахароснижающая терапия в основном проводилась пероральными препаратами (79,3%). Большая часть населения (66,3%) показала недостаточный контроль уровня гликемии (глюкоза плазмы крови находилась в диапазоне от 131 до 500 мг/дл), трудовая деятельность этих пациентов в основном характеризовалась низкой физической активностью (у 64%). Оценка ИМТ показала, что более 35% пациентов имеют избыточный вес, а 23% страдают ожирением. У пациентов с АГ, получавших антигипертензивное лечение, наблюдалось значимое повышение уровня глюкозы в крови по сравнению с теми, у кого не была диагностирована АГ (P<0,001).
ЗАКЛЮЧЕНИЕ. Распространенность ожирения, АГ и недостаточного гликемического контроля у пациентов с СД2 высока, особенно у женщин.

КЛЮЧЕВЫЕ СЛОВА: сахарный диабет 2 типа; ожирение; гипертензия

TYPE 2 DIABETES WITH OBESITY AND HYPERTENSION: PREVALENCE AND SOCIODEMOGRAPHIC RISK FACTORS IN YEMEN

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BACKGROUND: Diabetes Mellitus is a rapidly growing and challenging health issue of the 21st century. Type 2 diabetes (T2D) is a major risk factor for obesity and hypertension (HTN). The prevalence of HTN and obesity in T2D patients is not well documented in the country of Yemen.
AIM: The focus of this study was to assess the prevalence of hypertension and obesity in patients with type 2 diabetes mellitus in Yemen.
METHODS: A cross-sectional study was carried out in Dhamar city hospitals. Patients diagnosed with diabetes (300 males and females: 30 years old and/or above) visiting an endocrinology and diabetes clinic in Dhamar city hospital for the first time were examined and evaluated for blood glucose levels, mode of treatment, duration of the disorder and body mass index. Socio-demographic and clinical data were collected using pretested questionnaires. Ethical approval was obtained from corresponding ethical committees from Dhamar University and hospitals. Data were analyzed using SPSS 23 version.
RESULTS: The prevalence of overweight and/or obesity in T2D was 60.67%, and hypertension was 35.66%. The occurrence of T2D was predominant in females (56.33%), patients with an age over 50 years (61%), and rural dwellers (74%). The mode of treatment was mainly through oral antihyperglycemic and hypoglycemic agents (79.3%). A large population (66.3%) showed poor control of blood glucose levels ranging from more than 131 to 500 mg/dL and the type of work these patients were involved in was mostly physically inactive (64%). The body mass index revealed that more than 35% were found to be overweight and 23% to be obese. Patients with hypertension and undergoing treatment for the same showed a significant (P < 0.001) increase in blood glucose level compared to those who were not diagnosed with HTN.
CONCLUSION: The prevalence of obesity, HTN, and poor glycemic control in patients with T2D is high, especially in females.

KEYWORDS: type 2 diabetes; obesity; hypertension

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BACKGROUND

Diabetes mellitus is identified as a non-communicable disease and a major threat to society and economies by the World Health Organization [1]. It usually develops as a consequence over a long period of time due to uncontrolled diet or maintenance of health behavior [2]. The complications associated with diabetes could be minimized or prevented by controlling the risk factors such as obesity and hypertension [1]. Obesity is progressively affecting a large population worldwide leading to many adverse metabolic and cardiovascular outcomes. Obesity and hypertension (HTN) are increasingly concerning among them. The pathophysiology of obesity and HTN has not yet been fully elucidated despite it being one of the oldest known diseases to mankind [3]. Obesity, especially when it is associated with increased visceral adiposity becomes a major contributor to cause hypertension, accounting for nearly 65 to 75% of the risk for human primary (essential) hypertension [4]. There are several factors that contribute to the development of obesity and hypertension. However, with prolonged obesity and the development of target organ injury, obesity-associated hypertension becomes more difficult to control. This prompts multiple usages of antihypertensive drugs and demands the treatment of other risk factors, including dyslipidemia, insulin resistance, and inflammation [4]. Unless effective drugs are developed, the effect of obesity on hypertension and related metabolic disorders like diabetes, especially type 2 diabetes mellitus is likely to become even more important in the future as the prevalence of obesity continues to increase across the globe.

In Yemen, the prevalence of HTN and obesity in type 2 diabetes (T2D) patients is not well documented. Although, the high prevalence of HTN, overweight, and obesity in developing countries is due to urbanization, changing lifestyles, and food habits, this problem is also not well studied or addressed in Yemen. As to the knowledge of the investigators, there are no data available on the prevalence of HTN, overweight, and obesity among diabetic patients in the study area. Therefore, the present study aimed with an intention to evaluate the relationship between obesity and, T2D with respect to age and body mass index (BMI) and to determine the prevalence of hypertension associated with T2D.

METHODS

Study Area and Setting

This study was conducted from August to November 2020 at Dhamar city hospitals, located 100 km away to the south of Sana'a, the capital of Yemen. The samples were collected from Al-Dobai Labs, Dr. Mohammed Al-Musli Hospital, and Taiba Consulting Hospital in Dhamar city. These hospitals and labs are highly accessible to patients from all districts in Dhamar city.

Sample Size

The samples were taken randomly from patients with diabetes using Cochran's formula [5]:

$$n_0 = \frac{z^2pq}{e^2}$$

Where,
'n_o' is the sample size derived from equation.
'Z' is the selected critical value (1.96) of confidence level 95%.
'e' is the desired level of precision 0.05.
'p' is the estimated proportion of an attribute that is present in the population 0. 25.
'q' is equal to 1- p.

$$n_0 = \frac{(1.96)^2 * 0.25(1-0.5)}{(0.05)^2} = 288.12$$

Study Design and Population

Three hundred patients were enrolled in this study upon receiving their consent. Diabetic patients attending the internal medicine clinic or diabetic clinic in the above-mentioned hospitals were chosen for the study. Patients who participated in this study were already diagnosed with T2D during their previous routine visit. The diagnostic criteria were followed as per the recommendations of American Diabetic Association [6].

Inclusion and Exclusion Criteria

Patients with a pre-history of T2D were included in the study. While patients with T1D and those who were not willing to participate were excluded.

Data collection

A semi-structured questionnaire was used to collect data on the socio-demographic characteristics, lifestyle, and clinical history of the patients. The patients were requested to present the fasting blood glucose level (FBG) reports of the previous examination. Data obtained included age, duration of diabetes, and blood pressure (BP). The weight was recorded in kilograms by using a weighing scale (personal scale not for business counting), and the height was in meters. The body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters [7]. HTN was diagnosed using an aneroid sphygmomanometer, with a systolic BP of greater than or equal to 140 mmHg or diastolic blood of greater than or equal to 90 mmHg on at least two occasions, or if the patient was on the antihypertensive drug [8].

Ethical approval

This study was approved by the human ethical committee of Dhamar University. Samples were collected after permission was granted by the authorities of the corresponding hospitals.

Data analysis

Data were analyzed using Statistical Package for Social Science (SPSS) version 23 software. Continuous variables were presented as frequency and mean ± SD. Categorical variables were compared with one-way ANOVA. P-value of less than 0.05 was considered to be statistically significant.

RESULTS

General Characteristic

Out of the 300 subjects involved in the study, 56.33% of them were females, and the rest were males. The commonly affected age group was found to be over 60 years

Table 1. General characteristics of the study population

Variables		Frequency	Percent (%)
Age, years	30–50	117	39.00
	>50	183	61.00
Gender	Male	131	43.70
	Female	169	56.30
Location	Rural	222	74.00
	Urban	78	26.00

(61%) and most of the subjects were observed to be living in rural areas (74%), while those from the urban area were accounting to 26% (Table 1).

Clinical characteristic

As per the results obtained (Table 2), the frequency and percentage (55.3%) of the population with type 2 diabetes were found to be diagnosed in less than or equal to five years of duration. The remaining population (44.7%) was found to be diabetic for more than five years. The mode of treatment was mainly through oral antihyperglycemic and hypoglycemic agents (79.3%) followed by patients on both oral medication and diet plans. Also, a very less percentage; 5.7 and 1.7% of patients were found to be controlling their blood glucose level through diet and insulin, respectively. We also observed that only 74% of people with diabetes were measuring their blood glucose level consistently at regular intervals. It was surprising to learn that, a very less percentage (33.7%) of people were having their fasting blood glucose levels in the reference range of 80–130 mg/dL and the remaining population showed poor control of blood glucose levels ranging from more than 131 to 500 mg/dL. Interestingly, we found that 35.7% of the patients were hypertensive, and some of them were not taking antihypertension drugs. The type of work these patients involved were mostly physically inactive (64%), whereas, 39.3% of them were in an active mode of work that demanded physical activity. The body mass index revealed that less than 40% of patients had normal BMI, while, more than 35% were found to be overweight and 23% to be obese. In addition to this, the overall prevalence of HTN among the study population was 35.67%.

Fasting Blood Glucose in T2D

The FBS based on the socio-demographic characteristics was slightly high in male patients over 50 years, and rural dwellers, but there was no noticeable significant difference with age. Both age groups continued to show similar blood glucose patterns. However, there was a significant difference observed in terms of gender (P<0.045) and

Table 2. Clinical characteristics of the study population

Variables		Frequency	Percent (%)
Duration of T2D (years)	≤5	166	55.3
	>5	134	44.7
Mode of treatment	Tablets	238	79.3
	Diet	17	05.7
	Tablets and Diet	40	13.3
	Insulin	05	01.7
Examination of blood glucose level	Yes	222	74.0
	No	78	26.0
Diabetic state FBG (mg/dL)	131–500 (Uncontrolled)	199	66.3
	80–130 (Controlled)	101	33.7
Treatment for HTN	Yes	101	94.4
	No	06	05.6
Type of work	Active	108	36.0
	Inactive	192	64.0
BMI	Normal	118	39.3
	Overweight	113	37.7
	Obesity	69	23.0

Note: T2D — type 2 diabetes mellitus, FBG — fasting blood glucose, HTN — hypertension, BMI — body mass index.

Table 3. Fasting blood glucose in type 2 diabetes mellitus based on the socio-demographic characteristic

Variables		Fasting Blood Glucose (mg/dL)
Age	30–50 years	137.91±27.23
	>50 years	138.68±28.79
	P-value	0.814
Gender	Male	142.03±29.99
	Female	135.49±26.26
	P-value	0.045
Location	Rural	140.26±29.13
	Urban	132.91±24.23
	P-value	0.047

location (P<0.047) (Table 3). Based on the clinical characteristics, the duration of T2D, mode of treatment, and type of work engaged in did not show any impact or difference in the blood glucose level. While patients with hypertension and undergoing treatment for the same, showed a significant (P<0.001) increased blood glucose level in comparison to those who were not diagnosed with HTN or on treatment with antihypertensive agents. Interestingly, we observed a significant difference (P<0.001) in the blood glucose levels in obese patients compared to normal and overweight patients. It is striking that, patients with hypertension and/or obesity were found to be having a slightly high but significant change in the blood glucose pattern (Table 4).

Table 4. Fasting Blood Glucose in type 2 diabetes mellitus based on clinical characteristics

Variables		Fasting Blood Glucose (mg/dL)
Duration of T2D (years)	≤5	139.12±28.55
	>5	134.55±25.67
	P-value	0.290
Mode of treatment	Tablets	139.18±28.65
	Diet	129.59±12.78
	Tablets and Diet	139.43±30.05
	Insulin	119.80±9.09
	P-value	0.251
Examination of blood glucose level	Yes	139.45±28.10
	No	135.21±28.01
	P-value	0.252
HTN	Yes	168.53±25.07
	No	121.61±9.63
	P-value	<0.001
Treatment for HTN	Yes	169.28±25.31
	No	122.65±11.51
	P-value	<0.001
Type of work	Active	138.49±27.37
	Inactive	138.09±29.45
	P-value	0.907
BMI	Normal	136.24±28.32
	Overweight	128.68±18.57
	Obesity	158.68±30.46
	P-value	<0.001

Note: T2D — type 2 diabetes mellitus, HTN — hypertension, BMI — body mass index.

Table 5. The relative risk factors of diabetes

Variables		Controlled FBG (%)	Uncontrolled FBG (%)	OR–CI 95%	P-value
Age, years	30–50	33.3	66.7	1	0.922
	>50	33.9	66.1	1.010–0.834	
Gender	Male	20.6	79.4	1	<0.001
	Female	43.8	56.2	1.545–1.273	
Location	Rural	35.1	64.9	1.067–0.931	0.360
	Urban	29.5	70.5	1	
Duration of T2D, years	≤5	34.9	65.1	1.058–0.857	0.603
	>5	32.1	67.9	1	
Examination of blood glucose level	Yes	28.4	71.6	1	<0.001
	No	48.7	51.3	1.872–1.288	
Treatment for diabetes	Tablet or insulin	52.2	47.8	1	0.057
	Insulin	32.1	67.9	0.434–0.184	
Hypertension	Yes	15.9	84.1	1	<0.001
	No	43.5	56.5	1.518–1.302	
BMI	Normal weight	77.1	22.9	1	<0.001
	Overweight and obesity	05.5	94.5	6.642–4.649	
Type of work	Active	33.3	66.7	1	0.927
	Inactive	33.9	66.1	1.008–0.843	

Note: OR — odds ratio, CI — confidence interval, T2D — type 2 diabetes mellitus, BMI — body mass index.

Risk factors of T2D

A higher percentage of uncontrolled fasting blood glucose levels was predominantly found in males in comparison to females and those individuals with hypertension continued to show abnormal levels of blood glucose. The body mass index reflected the fact that 94.5% of overweight and obese patients were having uncontrolled levels in comparison to normal-weight individuals. The above-mentioned variables were found highly significant (P<0.001). However, we did not find any noticeable difference in variables such as age, location, duration of T2D, type of work, and mode of treatment (Table 5).

DISCUSSION

Obesity and hypertension (HTN) are the two major risk factors associated with type 2 diabetes (T2D). The study included the general characteristics and in terms of percent of occurrence, 56.3% of the participants were females, 74% were rural dwellers, 36% were involved in active work and 79.3% were on oral antidiabetic drugs. In addition to this, 37.7 and 23% were overweight and obese, respectively.

The present study indicates that the prevalence of hypertension in T2D patients in Dhamar city was 35.7%. Slightly contradictory to this observation, reports from several investigators have shown that HTN is very prevalent with T2D. One such study carried out in Iraq between August 2008 and April 2011 involving 5,578 patients with T2D showed that diabetic patients having hypertension constituted around 89.6%, and 45.3% of them were diagnosed during the study period [9]. Similar studies conducted in Germany and Ethiopia showed that 73.5% of German adults having T2D were diagnosed with hypertension in the year 2009 and in Ethiopia, a study carried out from October 2008 to February 2009 was found to be 67.1%. Several review articles reported that diabetes associated with HTN rates above 60%, even exceeding 75% in many of the studies. The prevalence of HTN in India, Japan, and Iran was estimated below 50%, [10] [11] [12] [13] whereas, Mexico, Romani, and Taiwan had single or highest estimates just above 50% and these are higher [14] [15] [16] [17] compared to our study results.

The overall prevalence of overweight and obesity among T2D in this study was 37.7 and 23%, respectively. Participants were sorted into groups; BMI greater than or equal to 25 kg/m^2 was considered normal, 25–30 kg/m^2 as overweight, and obese with a BMI greater than or equal to 30 kg/m^2. This outcome is lower when compared to studies carried out in other gulf countries; Qatar and Jordan, 53.5 and 58.6%, respectively [18][19]. In Iran and Saudi Arabia, 85.5 and 83.45%, respectively [20] [21].

Individuals with an age over 50 years were the most predominant with a history of T2D (61%) and this frequency or percentage found in Dhamar city of Yemen is higher than in neighboring Arab countries such as Saudi Arabia; 23.1%, among patients aged 7 to 80 years [21], Bahrain; 25.7% among patients aged 20 years or older [22] and Oman; 16.1% among patients aged 30 to 64 years [23].

In the present study, the occurrence of T2D in females was (56.3%) more than in males. A similar observation has been reported in one of the studies carried out in Iran wherein, females were found to be highly predominant in comparison to males [24]. We speculate that the resemblance of our results with that of a study conducted in Iran could be due to women spending more time at home and being physically

inactive like women in Arabic countries [25]. In agreement with the above, a particular study reported that obesity and diabetes in males and females between the age group of 15 to 64 years in Arabic countries are mainly due to lifestyle, socioeconomic factors, and weak legislation [26].

Our study has some limitations since it is a single-center study with most of the patients from Dhamar city and the surrounding regions. Studies covering a larger area with different regions of Yemen should be conducted to ascertain the similar differences in terms of obesity and hypertension in both male and female patients having T2D. In addition to this, further studies are required to assess the factors and mechanisms causing obesity and hypertension in these patients and if possible, slow down the increasing rate of obesity and associated metabolic diseases.

CONCLUSION

In conclusion, factors such as overweight, obesity (high BMI), and hypertension were prevalent in patients with T2D in Dhamar city of Yemen, with a higher frequency in females than in males. The mean BMI, as a continuous variable associated with morbidity and mortality, was significantly higher in females than in males in different age groups. The finding of poor glycemic control among the majority of patients was another alarming sign of low-quality diabetes care in this country. We strongly recommend improving the standards of diabetes health care in Yemen at the primary and critical care levels in order to reduce the burden attributable to T2D.

DECLARATIONS

Availability of data and materials. All data generated/produced or analyzed during this study are included in this published article [and its supplementary information files].

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Authors' contributions. SM carried out the study, analyzed and interpreted the patient data. KG conceptualized the study design and was a major contributor to writing the manuscript. Both authors read and approved the final manuscript.

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Conflict of Interest. The authors declare no conflict of interest.

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