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National cross-sectional data on undiagnosed type 2 diabetes among adults in Iraq

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Abstract

Objectives The study aimed to estimate the prevalence and associated factors of undiagnosed type 2 diabetes (T2D) among adults in Iraq.

Research design and methods Cross-sectional data were analyzed from 3,853 persons (≥18 years, mean age 41.8 years) who participated in the Iraq STEPS survey in 2015, who had complete fasting blood glucose measurement.

Results The prevalence of undiagnosed T2D was 8.1% (47.6% of total T2D), diagnosed T2D 8.9%, and total T2D 17.0%. In the adjusted multinomial logistic regression analysis, older age (≥50 years) (ARRR: 2.11, 95% CI: 1.30-3.43) and elevated total cholesterol (ARRR: 1.54, 95% CI: 1.05-2.24) were positively associated with undiagnosed T2D. Older age (≥50 years) (ARRR: 17.90, 95% CI: 8.42-38.06), received health care advice (ARRR: 2.15, 95% CI: 1.56-2.96), ever cholesterol screening (ARRR: 2.17, 95% CI: 1.58-2.99), heart attack or stroke (ARRR: 1.81, 95% CI: 1.13-2.92), and elevated total cholesterol (ARRR: 1.55, 95% CI: 1.17-2.06) were positively associated with diagnosed T2D, and high physical activity (ARRR: 0.57, 95% CI: 0.38-0.84) was negatively associated with diagnosed T2D. In adjusted logistic regression analysis, more than primary education (AOR: 2.02, 95% CI: 1.21-3.37) was positively, older age (≥50 years) (AOR: 0.12, 95% CI: 0.06-0.25), health care advice (AOR: 0.45, 95% CI: 0.29-0.70), and ever cholesterol screening (AOR: 0.37, 95% CI: 0.24-0.58) were negatively associated with undiagnosed T2D versus diagnosed T2D.

Conclusion A significant proportion of adults in Iraq had undiagnosed T2D, and several associated factors were identified which can help in guiding interventions.

***Keywords**:* undiagnosed type 2 diabetes, adults, Iraq

What is already known about this subject?

- The prevalence of undiagnosed T2D has been reported in various countries
- To better identify undiagnosed T2D, it is important to understand its risk factors

What are new findings?

- We report for the first-time national data on the prevalence of undiagnosed T2D in Iraq, including a risk factor model consisting of predisposing, enabling/disabling and need factors of undiagnosed T2D.

How might these results change the focus of research or clinical practice?

- Our results will inform the Iraq national strategy to prevent and control diabetes.

Introduction

According to the World Health Organization [1], an "estimated 1.5 million deaths are directly caused by diabetes in 2019; diabetes can be treated, and its consequences avoided or delayed with diet, physical activity, medication and regular screening and treatment for complications." Untreated undiagnosed type 2 diabetes (T2D) may have serious consequences, including microvascular and macrovascular complications [2,3] and an increased risk of mortality [4,5], emphasizing the crucial importance of early diagnosis. In 2021, "almost one in two adults (20–79 years old) with T2D were unaware of their T2D status (44.7%), with the highest proportions in Africa (53.6%), Western Pacific (52.8%) and South-East Asia regions (51.3%), and the lowest in North America and the Caribbean (24.2%)" [6]. In an earlier review of studies in 29 low- and middle-income countries (LMICs) the prevalence of undiagnosed T2D was 4.9% [7]. For example, in Suriname, 39.6% of people with T2D had not been diagnosed previously [8], in northern Sudan among people with T2D 29.0% were newly diagnosed [9], in Basrah, Iraq, the prevalence of undiagnosed T2D was 11.0% (55.8% of total T2D) [10], and among the Chinese adult population, the prevalence of undiagnosed T2D was 6.9% (63.3% of total T2D) [11]. There is a lack of national data on undiagnosed T2D and its correlates in Iraq [12].

Undiagnosed T2D can be conceptualized in problems using health services [13], using Andersen's behavioural model of health service utilization [14]. According to this model, health care utilization can be conceptualized into predisposing factors (demographic characteristics), enabling factors (objective conditions that may facilitate or impede the use of health services), and need factors (perceived and evaluated need for health services) [14].

Predisposing factors associated with undiagnosed T2D included age (younger age [15-17], older age [13,18-20], lower among age ≥ 70 years vs. 35-39 years [21], male sex [16-18], living alone [17,22], marital or cohabitation status [22], ethnic minority [23], ethnicity [24], and family history of diabetes [25,26]. Enabling/disabling factors associated with undiagnosed T2D include socioeconomic status (lower economic status [15,21], food insecurity [27], higher economic status [18], lower education [16,28], higher education [21], rural residence [13,15], geographical regions [13,16,17,29], know symptoms of diabetes [25], no health care visit in the past 12 months [17], health insurance status (medical insurance [13], not private insurance [30]), and health risk behaviours (high sedentary behaviour [12], heavy alcohol use [31], high level of physical activity [21], and fitness compared to peers [19].

The need factors associated with undiagnosed T2D include other chronic diseases [13], hypertension status (not hypertension [15,16], hypertension [18,19,31,32]), obesity [18-20,25,26,31,33], low HDL-C [33,34], high triglycerides [33,34], dyslipidaemia [26], cardiovascular disease status (not heart disease [16], cardiovascular disease [19]), and poor perceived health [13].

The study aimed to estimate the prevalence and associated factors of undiagnosed T2D among people (15-69 years) in Iraq.

Methods

Study design and participants

Secondary data from the STEPS cross-sectional survey in Iraq in 2015 [35] with complete measurements of fasting blood glucose were analyzed; the overall response rate was 93.0% [36]. Following the STEPS survey procedures, "Socio-demographic and behavioural information was collected in Step 1. Physical measurements such as height, weight, and blood pressure were collected in Step 2. Biochemical measurements were collected to assess blood glucose and cholesterol levels in Step 3."[35] "Blood glucose, total cholesterol and triglycerides were measured in peripheral (capillary) blood at the data collection site using dry chemical methods, biochemical analysis and automated analyzer."

"A multi-stage stratified sampling process was carried out to randomly select participants from the target population (18 years and older)" [36]. Ethics approval was provided by the

"Republic of Iraq Ministry of Health/Environment Public Health Directorate" and written informed consent was obtained from the participants.

Measures

Outcome variable

Undiagnosed T2D was defined as fasting plasma glucose level ≥126 mg/dL among people who responded "no" the question "Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?" [35].

Predisposing factors included age, sex, marital status, and ethnic group.

Enabling or disabling factors included residence status, health care advice, ever screening for cholesterol, smoking tobacco history, physical activity, and sedentary behaviour (≥8 hours sitting a day). Health care advice was assessed with the question, "During the past three years, has a doctor or other health worker advised you to maintain a healthy body weight or lose weight?" (yes/no). Smoking history was assessed with two questions, "Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?" (Yes, No) and "In the past, did you ever smoke any tobacco products?"(Yes, No) [36]. Self-reported physical activity and sedentary behaviour were assessed with the Global Physical Activity Questionnaire (GPAQ) and categorized by the median metabolic equivalent (METs) of performed activities as low, moderate, and high [37], and sedentary behaviour defined as ≥8 hours sitting/day [38].

Need factors included BMI, hypertension, heart attack or stroke, and elevated total cholesterol. Body Mass Index (BMI) was classified as "underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obesity (≥30.0 kg/m^2)." [35]. Hypertension was defined as "systolic BP ≥140mmHg and/or diastolic BP ≥90mmHg and/or previously or current treatment with antihypertensive drugs." [39] History of heart attack or stroke included self-reported "Have you ever had a heart attack or chest pain from heart disease (angina) or a stroke (cerebrovascular accident or incident)? (Yes, No)." [36]. Elevated total cholesterol was classified [40] as: "being on antilipidemic medication or having elevated total cholesterol (TC): ≥5.17 mmol/l (200 mg/dl)."

Data analysis

All statistical analyses were conducted with "STATA software version 14.0 (Stata Corporation, College Station, TX, USA)." "Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population." [36]. Descriptive statistics are used to describe the sample. Multinomial logistic regression was used to estimate factors associated with undiagnosed T2D and diagnosed T2D (with not having T2D as reference category). Logistic regressions were used to assess the associations with undiagnosed T2D versus diagnosed T2D. Covariates in the logistic regression models included predisposing factors (age, gender, and marital status), enabling, or disabling factors (residence status, health care advice, cholesterol screening, education, smoking status, physical activity, and sedentary behaviour) and need factors (BMI, hypertension, heart attack or stroke, and elevated total cholesterol). Variables significant in univariate analyses were subsequently included in the multivariable models. To account for the multi-stage sample design, Taylor linearization methods were utilized. P-values <0.05 were considered significant, and missing values were discarded.

Patient and Public Involvement

Participants were not involved in the design of the study, recruitment or conduct of the study.

Results

Sample characteristics

The sample with complete fasting blood glucose measurement included 3,853 persons (≥18 years), with a mean age of 41.8 years (SD=15.8 years) in 2015. The prevalence of undiagnosed T2D was 8.1% (47.6% of total T2D), diagnosed T2D 8.9%, and total T2D 17.0%. Further sociodemographic and health characteristics of the sample by T2D status are described in Table 1 (see Table 1).

Table 1: Sample characteristics, Iraq 2015

Variable	Sample	No diabetes	Undiagnosed diabetes	Diagnosed diabetes
N	3853	3070	326	457
	N (%)	%	%	%
All		83.0	8.1	8.9
Predisposing factors				
Age (years)				
18-34	1439 (56.1)	93.2	6.0	0.8
35-49	1271 (23.1)	79.2	9.9	10.9
50 or more	1132 (20.8)	60.0	11.5	28.5
Gender				
Female	2331 (47.9)	82.8	7.9	9.3
Male	1522 (52.1)	83.3	8.2	8.5
Marital status				
Not married	948 (32.3)	87.5	7.1	5.4
Married	2900 (67.7)	80.9	8.5	10.6
Enabling/disabling factors				
Residence				
Rural	838 (24.3)	82.8	8.9	8.3
Urban	3015 (75.7)	83.1	7.8	9.1
Health care advise (past 3 years)				
No	2050 (55.0)	87.3	8.1	4.7
Yes	1802 (45.0)	77.9	8.1	14.1
Ever cholesterol screening				
No	2888 (78.7)	87.3	8.0	4.7
Yes	965 (21.3)	67.3	8.2	24.5
Education				
<Primary	1690 (38.2)	79.7	8.2	12.1
Primary	979 (24.6)	84.5	7.2	8.3
>Primary	1164 (37.2)	85.6	8.5	5.9
Smoking tobacco				
Never	2929 (72.1)	84.5	7.7	7.8
Past	304 (7.1)	68.6	11.8	19.6
Current	620 (20.8)	82.9	8.0	9.1
Physical activity				
Low	2158 (52.9)	80.4	8.8	10.9
Moderate	886 (22.4)	81.4	8.5	10.1
High	805 (24.7)	90.3	6.1	3.6
Sedentary behaviour	1092 (26.3)	78.9	9.1	12.0
Need factors				
Body mass index				
<25 kg/m^2	958 (34.5)	89.5	6.8	3.7
Overweight	1219 (31.6)	82.4	7.8	9.8
Obesity	1560 (33.9)	76.3	9.7	14.0
Hypertension	1652 (35.5)	71.4	10.6	18.0
Heart attack or stroke	232 (4.3)	50.1	8.3	41.6

Elevated total cholesterol	1443 (33.7)	74.3	10.6	15.0

Associations with undiagnosed and diagnosed T2D versus no diabetes

In the adjusted multinomial logistic regression analysis, older age (≥50 years) (ARRR: 2.11, 95% CI: 1.30-3.43) and elevated total cholesterol (ARRR: 1.54, 95% CI: 1.05-2.24) were positively associated with undiagnosed T2D. Older age (≥50 years) (ARRR: 17.90, 95% CI: 8.42-38.06), received health care advice (ARRR: 2.15, 95% CI: 1.56-2.96), ever cholesterol screening (ARRR: 2.17, 95% CI: 1.58-2.99), heart attack or stroke (ARRR: 1.81, 95% CI: 1.13-2.92), and elevated total cholesterol (ARRR: 1.55, 95% CI: 1.17-2.06) were positively associated with diagnosed T2D, and high physical activity (ARRR: 0.57, 95% CI: 0.38-0.84) was negatively associated with diagnosed T2D. In addition, in unadjusted analyses, past tobacco smoking , obesity, and hypertension were positively and high physical activity negatively associated with undiagnosed T2D (see Tables 2 and 3).

Table 2: Unadjusted associations with undiagnosed and diagnosed diabetes

	Undiagnosed diabetes	Diagnosed diabetes
Variable	Unadjusted RRR (95% CI)	Unadjusted RRR (95% CI)
Predisposing factors		
Age (years) 18-34 35-49 50 or more	 1 (Reference) 1.92 (1.34-2.74)*** 2.95 (1.97-4.43)***	 1 (Reference) 15.97 (8.74-29.17)*** 55.27 (29.99-101.87)***
Gender Female Male	 1 (Reference) 1.03 (0.75-1.42)	 1 (Reference) 0.91 (0.71-1.16)
Marital status Not married Married	 1 (Reference) 1.31 (0.90-1.89)	 1 (Reference) 2.12 (1.52-2.96)***
Enabling/disabling factors		
Residence		

Rural	1 (Reference)	1 (Reference)
Urban	0.87 (0.54-1.40)	1.10 (0.79-1.53)
Health care advise (past 3 years)		
No	1 (Reference)	1 (Reference)
Yes	1.12 (0.81-1.57)	3.39 (2.56-4.48)***
Ever cholesterol screening		
No	1 (Reference)	1 (Reference)
Yes	1.33 (0.94-1.88)	6.77 (5.17-8.86)***
Education		
<Primary	1 (Reference)	1 (Reference)
Primary	0.84 (0.57-1.23)	0.65 (0.49-0.85)**
>Primary	0.97 (0.67-1.39)	0.46 (0.33-0.64)***
Smoking tobacco		
Never	1 (Reference)	1 (Reference)
Past	1.88 (1.14-3.09)*	3.10 (2.15-4.46)***
Current	1.05 (0.67-1.65)	1.20 (0.86-1.67)
Physical activity		
Low	1 (Reference)	1 (Reference)
Moderate	0.96 (0.62-1.49)	0.92 (0.68-1.24)
High	0.62 (0.39-0.99)*	0.29 (0.20-0.42)***
Sedentary behaviour	1.25 (0.83-1.87)	1.66 (1.27-2.17)***
Need factors		
Body mass index		
<25 kg/m^2	1 (Reference)	1 (Reference)
Overweight	1.25 (0.81-1.94)	2.88 (1.94-4.29)***
Obesity	1.68 (1.12-2.50)*	4.44 (3.14-6.28)***
Hypertension	1.97 (1.43-2.70)***	5.78 (4.31-7.75)***
Heart attack or stroke	1.73 (0.95-3.15)	9.41 (6.40-13.83)***
Elevated total cholesterol	1.89 (1.30-2.60)***	3.03 (2.33-3.95)***

RRR=Relative Risk Ratio; CI=Confidence Intervals; *p<0.05; **p<0.01; ***p<0.001

Table 3: Adjusted associations with undiagnosed and diagnosed diabetes

	Undiagnosed diabetes	Diagnosed diabetes
Variable	Adjusted RRR (95% CI)	Adjusted RRR (95% CI)
Predisposing factors		
Age (years)		
18-34	1 (Reference)	1 (Reference)
35-49	1.59 (1.03-2.43)*	7.67 (3.86-15.25)***
50 or more	2.11 (1.30-3.43)**	17.90 (8.42-38.06)***
Marital status		
Not married	1 (Reference)	1 (Reference)
Married	1.06 (0.70-1.61)	1.31 (0.90-1.89)
Enabling/disabling factors		

Health care advise (past 3 years)		
No	1 (Reference)	1 (Reference)
Yes	1.03 (0.71-1.48)	2.15 (1.56-2.96)***
Ever cholesterol screening		
No	1 (Reference)	1 (Reference)
Yes	0.86 (0.58-1.27)	2.17 (1.58-2.99)***
Education		
<Primary	1 (Reference)	1 (Reference)
Primary	0.99 (0.64-1.51)	0.89 (0.63-1.26)
>Primary	1.26 (0.85-1.86)	0.72 (0.50-1.04)
Smoking tobacco		
Never	1 (Reference)	1 (Reference)
Past	1.43 (0.83-1.45)	1.19 (0.75-1.86)
Current	1.11 (0.69-1.78)	1.41 (0.98-2.03)
Physical activity		
Low	1 (Reference)	1 (Reference)
Moderate	0.88 (0.56-1.37)	0.90 (0.65-1.26)
High	0.72 (0.44-1.18)	0.57 (0.38-0.84)**
Sedentary behaviour	1.05 (0.70-1.58)	1.08 (0.79-1.48)
Need factors		
Body mass index		
<25 kg/m^2	1 (Reference)	1 (Reference)
Overweight	0.93 (0.58-1.51)	1.17 (0.74-1.83)
Obesity	1.07 (0.64-1.79)	1.14 (0.75-1.75)
Hypertension	1.39 (0.96-2.03)	1.43 (0.99-2.07)
Heart attack or stroke	0.94 (0.51-1.72)	1.81 (1.13-2.92)*
Elevated total cholesterol	1.54 (1.05-2.24)*	1.55 (1.17-2.06)**

RRR=Relative Risk Ratio; CI=Confidence Intervals; *p<0.05; **p<0.01; ***p<0.001

Associations with undiagnosed T2D versus diagnosed T2D

In adjusted logistic regression analysis, more than primary education (AOR: 2.02, 95% CI: 1.21-3.37) was positively, older age (≥50 years) (AOR: 0.12, 95% CI: 0.06-0.25), health care advice (AOR: 0.45, 95% CI: 0.29-0.70), and ever cholesterol screening (AOR: 0.37, 95% CI: 0.24-0.58) were negatively associated with undiagnosed T2D versus diagnosed T2D. In addition, in unadjusted analysis, high physical activity was positively and married, obesity, hypertension, heart attack or stroke and elevated total cholesterol were negatively associated with undiagnosed T2D versus diagnosed T2D (see Table 4).

Table 4: Associations with undiagnosed versus diagnosed diabetes

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Predisposing factors		
Age (years)		
18-34	1 (Reference)	1 (Reference)
35-49	0.12 (0.06-0.24)***	0.23 (0.11-0.46)***
50 or more	0.05 (0.03-0.11)***	0.12 (0.06-0.25)***
Gender		
Female	1 (Reference)	---
Male	1.13 (0.77-1.68)	
Marital status		
Not married	1 (Reference)	1 (Reference)
Married	0.62 (0.39-0.98)*	0.63 (0.37-1.06)
Enabling/disabling factors		
Residence		
Rural	1 (Reference)	---
Urban	0.79 (0.45-1.38)	
Health care advise (past 3 years)		
No	1 (Reference)	1 (Reference)
Yes	0.33 (0.22-0.50)***	0.45 (0.29-0.70)***
Ever cholesterol screening		
No	1 (Reference)	1 (Reference)
Yes	0.20 (0.13-0.29)***	0.37 (0.24-0.58)***
Education		
<Primary	1 (Reference)	1 (Reference)
Primary	1.29 (0.81-2.06)	0.93 (0.56-1.54)
>Primary	2.12 (1.32-3.38)**	2.02 (1.21-3.37)**
Smoking tobacco		
Never	1 (Reference)	---
Past	0.61 (0.35-1.04)	
Current	0.88 (0.51-1.51)	
Physical activity		
Low	1 (Reference)	1 (Reference)
Moderate	1.04 (0.62-1.75)	0.76 (0.45-1.30)
High	2.13 (1.19-3.80)*	1.18 (0.66-2.13)
Sedentary behaviour	0.75 (0.48-1.17)	---
Need factors		
Body mass index		
<25 kg/m^2	1 (Reference)	1 (Reference)
Overweight	0.43 (0.24-0.78)**	0.68 (0.37-1.26)
Obesity	0.38 (0.23-0.62)***	0.81 (0.45-1.46)
Hypertension	0.34 (0.23-0.50)***	0.82 (0.52-1.30)
Heart attack or stroke	0.18 (0.10-0.34)***	0.52 (0.26-1.05)
Elevated total cholesterol	0.61 (0.40-0.91)*	0.76 (0.50-1.16)

OR=Odds Ratio; CI=Confidence Intervals; *p<0.05; **p<0.01; ***p<0.001

Discussion

The study found a national prevalence of undiagnosed T2D (8.1%, 47.6% of total T2D), which is higher than recent global figures (44.7%) [6] and an earlier review of studies in 29 LMICs (4.9%) [7], and higher than in Suriname (39.6%) [8], in northern Sudan (29.0%) [9], and China (6.9%, 63.3% of total T2D) [11], but lower than in Basrah, Iraq (11.0%) [10]. People with undiagnosed T2D versus diagnosed T2D showed less diabetes-related comorbidities, such as younger age, no obesity, and no hypertension those with diagnosed T2D. This may be explained by people with undiagnosed T2D being generally younger and healthier than those with diagnosed T2D, mostly at an earlier stage of T2D [12].

Consistent with some previous research [13,16-20,24], some predisposing factors (older age) were associated with undiagnosed T2D versus no T2D. In addition, in unadjusted analysis, not married was associated with undiagnosed T2D versus diagnosed T2D, which is in agreement with some previous studies [17,22].

According to some previous studies [12,17,30], enabling / disabling factors associated with undiagnosed T2D versus diagnosed T2D included no health care advice (to lose weight) in the past three years, never screened for cholesterol, having higher education and high physical activity. People with health care advice and cholesterol screening are more likely to use health services and may consequently reduce the odds of undiagnosed T2D [13]. Following the management guidelines of T2D in Iraq, diabetic patients are expected to attend health care services more often [Abusaib], which may explain that people with diagnosed T2D visit health care providers more often than people with undiagnosed T2D [17]. Consistent with some studies [18,21], we found that higher education was associated undiagnosed T2D versus diagnosed T2D. While some studies [13,15] found an association between rural residence we did not find an association between education) and rural residence with undiagnosed T2D.

In agreement with some research [13,26,33,34] need factors associated with undiagnosed T2D included other chronic diseases, such as elevated total cholesterol. Some previous research [15,16,18-20,25,26,31-33] showed an association between hypertension status, and obesity with undiagnosed T2D versus no T2D, while we found negative associations with undiagnosed T2D

versus diagnosed T2D. Only heart attack or stroke was positively associated with diagnosed T2D.

Strengths and limitations

The study strengths include the use of nationally representative adult sample of all ages and standardized STEPS methodology and measures. Some variables were evaluated by self-report, which may have biased responses, and the cross-sectional design precludes causative conclusions between the evaluated variables. The sample only included those persons who were non-institutionalized, while the inclusion of institutionalized persons would have given different estimates. Furthermore, certain variables, such as knowledge of diabetes symptoms and a family history of diabetes, were not evaluated and should be included in future research.

Implications for public health research and practice

Policy implications are that increased public awareness campaigns, and screening of T2D are needed to reduce undiagnosed T2D in Iraq. The Iraq national NCD programme includes community awareness campaigns on diabetes, screening/early detection, and integrated care for diabetes, strengthening the capacities of health workers in primary health care centers to provide advice regarding early detection of diabetes, and inclusion for first-line treatment for diabetes as essential medicines list for primary health care centers [41]. In addition, an expert panel recommended further "screening for diabetes and pre-diabetes across the various regions of Iraq, and that the 'Finnish Diabetes Risk Score' (FINDRISC) is an appropriate screening tool for T2DM and should be made available to all asymptomatic patients across Iraq" [42].

Conclusion

A significant proportion of adults in Iraq had undiagnosed T2D. Predisposing factors (older age) and need factors (elevated total cholesterol) were identified as associated with undiagnosed T2D versus no T2D, and predisposing factors (younger age), and enabling / enabling factors (no health care advice, never been screened for cholesterol, higher education) were identified as associated with undiagnosed T2D versus diagnosed T2D, which can be targeted in interventions.

Contributors "All authors fulfil the criteria for authorship. SP and KP conceived and designed the research, performed statistical analysis, drafted the manuscript and made critical revision of

the manuscript for key intellectual content. All authors read and approved the final version of the manuscript and have agreed to authorship and order of authorship for this manuscript."

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Competing Interests None declared.

Data sharing statement

The data source is publicly available at the World Health Organization NCD Microdata Repository (URL: https://extranet.who.int/ncdsmicrodata/index.php/catalog).

Participant consent Obtained

Ethical approval Ethics approval was provided by the "Republic of Iraq Ministry of Health/Environment Public Health Directorate" (no approval number).

Acknowledgement

"The data source, the World Health Organization NCD Microdata Repository (URL: https://extranet.who.int/ncdsmicrodata/index.php/catalog), is hereby acknowledged."

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2	
Objectives	3	State specific objectives, including any prespecified hypotheses	3	
Methods				
Study design	4	Present key elements of study design early in the paper	4	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4	
Participants	6	a) ***Cohort study***—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up b) ***Case-control study***—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls c) ***Cross-sectional study***—Give the eligibility criteria, and the sources and methods of selection of participants	4	
		d) ***Cohort study***—For matched studies, give matching criteria and number of exposed and unexposed *e)* ***Case-control study***—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5	
Bias	9	Describe any efforts to address potential sources of bias	5	

STROBE Checklist

Study size	10	Explain how the study size was arrived at	5	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding		
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		
		(*b*) Report category boundaries when continuous variables were categorized		

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		
Generalisability	21	Discuss the generalisability (external validity) of the study results		
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		

***Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.**

BMJ Open

Prevalence and factors associated with undiagnosed type 2 diabetes among adults in Iraq: analysis of cross-sectional data from the 2015 STEPS survey

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Prevalence and factors associated with undiagnosed type 2 diabetes among adults in Iraq: analysis of cross-sectional data from the 2015 STEPS survey

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Abstract

Objective The purpose of the study was to assess the prevalence and correlates of undiagnosed type 2 diabetes (UT2D) among adults (aged 18 years and older) in Iraq.

Design Cross-sectional, population-based study.

Setting Nationally representative sample of general community-dwelling adult population in Iraq from the 2015 Iraq STEPS survey.

Participants The sample included 3,853 adults (mean age 41.8 years, SD=15.8), with complete fasting blood glucose values, from the 2015 Iraq STEPS survey.

Outcome measures Data collection included: 1) social and behavioural information, 2) physical parameters and blood pressure measurements, and 3) biochemical measurements. UT2D was classified as not being diagnosed with T2D and fasting plasma glucose level ≥126 mg/dL. Multivariable multinomial and logistic regression was used to identify factors associated with UT2D.

Results The prevalence of UT2D was 8.1% and the prevalence of diagnosed T2D (DT2D) was 8.9%. Participants aged 50 years and older (ARRR: 2.11, 95% CI: 1.30-3.43) and those with high cholesterol (ARRR: 1.54, 95% CI: 1.05-2.24) had a higher risk of UT2D. Older age (≥50 years) (ARRR: 17.90, 95% CI: 8.42-38.06), receipt of health care advice (ARRR: 2.15, 95% CI: 1.56-2.96), history of cholesterol testing (ARRR: 2.17, 95% CI: 1.58-2.99), stroke or heart attack (ARRR: 1.81, 95% CI: 1.13-2.92), and high cholesterol (ARRR: 1.55, 95% CI: 1.17-2.06) were positively associated with DT2D, and high physical activity (ARRR: 0.57, 95% CI: 0.38-0.84) was negatively associated with DT2D. Higher than primary education (AOR: 2.02, 95% CI: 1.21-3.37) was positively associated with UT2D versus DT2D, while older age (≥50 years) (AOR: 0.12, 95% CI: 0.06-0.25), health care advice (AOR: 0.45, 95% CI: 0.29-0.70), and history of cholesterol screening (AOR: 0.37, 95% CI: 0.24-0.58) were inversely associated with UT2D versus DT2D.

Conclusion Almost one in ten adults in Iraq had UT2D, and various associated factors were identified that could be useful in planning interventions.

***Keywords**:* undiagnosed, diagnosis, type 2 diabetes, adults, Iraq

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The study used a large, nationally representative community sample of adults of all ages in Iraq.
- Two regression models estimating risk factors consisting of predisposing, enabling/disabling and need factors of undiagnosed type 2 diabetes (T2D), diagnosed T2D versus no T2D, and undiagnosed T2D versus diagnosed T2D.
- The study was limited due to its cross-sectional design, the use of some self-reported measures, and the non-inclusion of some potentially relevant variables, such as family history and awareness of diabetes.

Introduction

In 2019, 1.5 million people died from diabetes, although diabetes can be treated [1]. If undiagnosed type 2 diabetes (UT2D) remains untreated serious morbidity [2,3] and mortality [4,5] may follow, emphasizing the need for early diagnosis. Globally, almost half (44.7%) of the adult population with T2D had UT2D [6]. In the general adult population of countries with lower resources, 4.9% had UT2D [7]. For example, in Suriname, 39.6% of people with T2D had not been previously diagnosed [8], in northern Sudan among people with T2D 29.0% were newly diagnosed [9], in Basrah, Iraq, the proportion of UT2D was 11.0% (55.8% of total T2D) [10], and among the Chinese adult population, the prevalence of UT2D was 6.9% (63.3% of total T2D) [11]. However, national prevalence data on UT2D in Iraq are lacking [12], which led to this study.

UT2D may be contextualized in terms of issues with health care use [13,14], including predisposing indicators (demographic characteristics), enabling indicators (enabling or limiting factors in relation to utilization of health care), and need indicators (health services need) [14]. Predisposing indicators associated with UT2D included age (decreasing age [15-17], increasing age [13,18-20], lower among age ≥ 70 years vs. 35-39 years [21], male sex [16-18], living alone [17,22], marital or cohabitation status [22], ethnic minority [23], ethnicity [24], and history of diabetes in the family [25,26]. Enabling/disabling indicators correlated with UT2D consist of

socioeconomic status [15,16,18, 21,27,28], geolocation and region [13,15,16,17], health care utilisation frequency [17], health insurance status [13,29], and lifestyle factors such as substance use and physical activity [12,19,21,30]. Need indicators linked to UT2D consist of chronic conditions [13], such as hypertension [15,16,18,19,30,31], obesity [18-20,25,26,30,32], abnormal lipids [26,32,33], and cardiovascular disease [16,19].

The aim of the study was to assess prevalence and correlates of UT2D persons 18 years and older in Iraq.

Methods

Sample and procedures

The study analysed cross-sectional data from the 2015 Iraq STEPS survey [34,35], including those with fasting blood glucose values (response rate 93.0%) [36]. One person (≥18 years) was randomly selected from each household using multi-stage stratified sampling (urban-rural, primary sampling units=70 plus households, one household); inclusion criteria were at least one month residing in Iraq and exclusion criteria were temporary residence, displaced and institutionalized adults [36]. Following the STEPS survey procedures, data collection included 3 steps: 1) social and behavioural information, 2) physical and blood pressure, and 3) biochemical measurements [35]. Blood glucose, total cholesterol and triglycerides were measured in peripheral (capillary) blood at the data collection site using dry chemical methods, biochemical analysis and automated analyser. [36]

Ethics approval for the STEPS survey was obtained from the Republic of Iraq Ministry of Health/Environment Public Health Directorate and participants provided informed consent. Additional ethics approval was not necessary for the use of anonymized data from STEPS in the present analysis.

Measures

Dependent variable: UT2D was classified as responding "no" to the question "Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?" and had fasting plasma glucose level ≥126 mg/dL; DT2D was defined as those who answered "yes"

to the question "Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?" [35].

Predisposing indicators: Marital status, sex and age.

Enabling/disabling indicators: Health care advice, history of cholesterol testing, sedentary behaviour, physical activity, and smoking history. Health care advice included, "During the past three years, has a doctor or other health worker advised you to maintain a healthy body weight or lose weight?" (yes/no). Smoking history was asked with questions on current and past use of any tobacco products [36]. Physical activity levels (low, moderate and high) and sedentary behaviour (≥8 hours sitting/day) were measured with the Global Physical Activity Questionnaire (GPAQ [37, 38].

Need indications: high total cholesterol, stroke or heart attack, hypertension, and body mass index (BMI). Definitions were as follows:

BMI: underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obesity (≥30.0 kg/m^2) [35]; hypertension: systolic BP ≥140mmHg and/or diastolic BP ≥90mmHg and/or previously or current treatment with antihypertensive drugs [39]; stroke or heart attack: "Have you ever had a heart attack or chest pain from heart disease (angina) or a stroke (cerebrovascular accident or incident)?" (yes/no) [36]; elevated total cholesterol: being on antilipidemic medication or having elevated total cholesterol (TC): ≥5.17 mmol/l (200 mg/dl). [40].

Statistical analysis

All statistical analyses were conducted with STATA software version 14.0 (Stata Corporation, College Station, TX, USA) by taking the complex study design into account [36]. Frequencies and percentage are used to describe the sample. Multinomial logistic regression was used to assess variables associated with UT2D and DT2D (reference category: no T2D). Binary logistic regression calculated associations with UT2D versus DT2D. Predisposing, enabling/disabling and need variables were included as covariates in the logistic regression models. Variables that turned out to be significant in univariate analyses were retained in the multivariable models. P-values <0.05 were accepted as significant.

Patient and public involvement

None.

Results

Participant characteristics

The final sample included 3,853 adults aged 18 years and older (M= 41.8 years, SD=15.8 years) in 2015. The proportion of UT2D was 8.1% (47.6% of total T2D), DT2D 8.9%, and total T2D 17.0%. More details are shown in Table 1.

Table 1: Characteristics of the sample (N=3853) according type 2 diabetes (T2D) status in adults, Iraq, 2015

Variable	Sample	T2D status		
		No	Undiagnosed	Diagnosed
N	3853	3070	326	457
	N (%)	%	%	%
All		83.0	8.1	8.9
Predisposing indicators				
Age in years				
18-34	1439 (56.1)	93.2	6.0	0.8
35-49	1271 (23.1)	79.2	9.9	10.9
50 or more	1132 (20.8)	60.0	11.5	28.5
Sex				
Female	2331 (47.9)	82.8	7.9	9.3
Male	1522 (52.1)	83.3	8.2	8.5
Marital status				
Not married	948 (32.3)	87.5	7.1	5.4
Married	2900 (67.7)	80.9	8.5	10.6
Enabling/disabling factors				
Residence				
Rural	838 (24.3)	82.8	8.9	8.3
Urban	3015 (75.7)	83.1	7.8	9.1
Health care advice (past 3 years)				
No	2050 (55.0)	87.3	8.1	4.7
Yes	1802 (45.0)	77.9	8.1	14.1
Ever cholesterol screening				
No	2888 (78.7)	87.3	8.0	4.7
Yes	965 (21.3)	67.3	8.2	24.5
Education				
<Primary	1690 (38.2)	79.7	8.2	12.1
Primary	979 (24.6)	84.5	7.2	8.3
>Primary	1164 (37.2)	85.6	8.5	5.9

Smoking tobacco				
Never	2929 (72.1)	84.5	7.7	7.8
Past	304 (7.1)	68.6	11.8	19.6
Current	620 (20.8)	82.9	8.0	9.1
Physical activity				
Low	2158 (52.9)	80.4	8.8	10.9
Moderate	886 (22.4)	81.4	8.5	10.1
High	805 (24.7)	90.3	6.1	3.6
Sedentary behaviour	1092 (26.3)	78.9	9.1	12.0
Need indicators				
Body mass index				
<25 kg/m^2	958 (34.5)	89.5	6.8	3.7
Overweight	1219 (31.6)	82.4	7.8	9.8
Obesity	1560 (33.9)	76.3	9.7	14.0
Hypertension	1652 (35.5)	71.4	10.6	18.0
Heart attack or stroke	232 (4.3)	50.1	8.3	41.6
Elevated total cholesterol	1443 (33.7)	74.3	10.6	15.0

Associations with UT2D and DT2D versus no diabetes

In the final adjusted model, 50 years and older (ARRR: 2.11, 95% CI: 1.30-3.43) and high cholesterol (ARRR: 1.54, 95% CI: 1.05-2.24) were positively associated with UT2D. Participants ≥50 years and older (ARRR: 17.90, 95% CI: 8.42-38.06), received advice from the health care provider (ARRR: 2.15, 95% CI: 1.56-2.96), history of cholesterol testing (ARRR: 2.17, 95% CI: 1.58-2.99), stroke or heart attack (ARRR: 1.81, 95% CI: 1.13-2.92), and high cholesterol (ARRR: 1.55, 95% CI: 1.17-2.06) were positively associated with DT2D, and high physical activity (ARRR: 0.57, 95% CI: 0.38-0.84) was negatively associated with DT2D. In addition, in unadjusted analyses, past tobacco smoking, obesity, and hypertension were positively associated, and high physical activity was negatively associated, with UT2D (see Tables 2 and 3).

Table 2: Unadjusted associations with undiagnosed type 2 diabetes (UT2D) and diagnosed (DT2D) in adults in Iraq, 2015

Variable	UT2D		DT2D	
	URRR (95% CI)	p-value	URRR (95% CI)	p-value
Predisposing indicators				

Sex				
Female	1 (Reference)		1 (Reference)	
Male	1.03 (0.75 to 1.42)	0.057	0.91 (0.71 to 1.16)	0.431
Age in years				
18-34	1 (Reference)		1 (Reference)	
35-49	1.92 (1.34 to 2.74)	<0.001	15.97 (8.74 to 29.17)	<0.001
50 or more	2.95 (1.97 to 4.43)	<0.001	55.27 (29.99 to 101.87)	<0.001
Marital status				
Not married	1 (Reference)		1 (Reference)	
Married	1.31 (0.90 to 1.89)	0.155	2.12 (1.52 to 2.96)	<0.001
Enabling/disabling indicators				
Education				
<Primary	1 (Reference)		1 (Reference)	
Primary	0.84 (0.57 to 1.23)	0.365	0.65 (0.49 to 0.85)	0.002
>Primary	0.97 (0.67 to 1.39)	0.853	0.46 (0.33 to 0.64)	<0.001
History of cholesterol testing				
No	1 (Reference)		1 (Reference)	
Yes	1.33 (0.94 to 1.88)	0.113	6.77 (5.17 to 8.86)	<0.001
Health care advice (past 3 years)				
No	1 (Reference)		1 (Reference)	
Yes	1.12 (0.81 to 1.57)	0.486	3.39 (2.56 to 4.48)	<0.001
Residence				
Rural	1 (Reference)		1 (Reference)	
Urban	0.87 (0.54 to 1.40)	0.568	1.10 (0.79 to 1.53)	0.564
Sedentary behaviour	1.25 (0.83 to 1.87)	0.279	1.66 (1.27 to 2.17)	<0.001
Physical activity				
Low	1 (Reference)		1 (Reference)	
Moderate	0.96 (0.62 to 1.49)	0.852	0.92 (0.68 to 1.24)	0.574
High	0.62 (0.39 to 0.99)	0.047	0.29 (0.20 to 0.42)	<0.001
Smoking tobacco				
Never	1 (Reference)		1 (Reference)	
Past	1.88 (1.14 to 3.09)	0.014	3.10 (2.15 to 4.46)	<0.001
Current	1.05 (0.67 to 1.65)	0.821	1.20 (0.86 to 1.67)	0.289
Need indicators				
Elevated total cholesterol	1.89 (1.30 to 2.60)	<0.001	3.03 (2.33 to 3.95)	<0.001
Heart attack or stroke	1.73 (0.95 to 3.15)	0.072	9.41 (6.40 to 13.83)	<0.001
Hypertension	1.97 (1.43 to 2.70)	<0.001	5.78 (4.31 to 7.75)	<0.001
Body mass index				
<25 kg/m^2	1 (Reference)		1 (Reference)	
Overweight	1.25 (0.81 to 1.94)	0.316	2.88 (1.94 to 4.29)	<0.001
Obesity	1.68 (1.12 to 2.50)	0.012	4.44 (3.14 to 6.28)	<0.001

CI=Confidence Intervals; URRR=Unadjusted Relative Risk Ratio.

Table 3: Adjusted associations with undiagnosed type 2 diabetes (UT2D) and diagnosed (DT2D) in adults in Iraq, 2015 (adjusted for all variables in the table)

Variable	UT2D		DT2D	
	ARRR (95% CI)	p-value	ARRR (95% CI)	p-value
Predisposing indicators				
Age in years				
18-34	1 (Reference)		1 (Reference)	
35-49	1.59 (1.03-2.43)	0.034	7.67 (3.86-15.25)	<0.001
50 or more	2.11 (1.30-3.43)	0.003	17.90 (8.42-38.06)	<0.001
Marital status				
Not married	1 (Reference)		1 (Reference)	
Married	1.06 (0.70-1.61)	0.781	1.31 (0.90-1.89)	0.156
Enabling/disabling indicators				
Education				
<Primary	1 (Reference)		1 (Reference)	
Primary	0.99 (0.64-1.51)	0.946	0.89 (0.63-1.26)	0.509
>Primary	1.26 (0.85-1.86)	0.254	0.72 (0.50-1.04)	0.079
Ever cholesterol screening				
No	1 (Reference)		1 (Reference)	
Yes	0.86 (0.58-1.27)	0.440	2.17 (1.58-2.99)	<0.001
Health care advice (past 3 years)				
No	1 (Reference)		1 (Reference)	
Yes	1.03 (0.71-1.48)	0.879	2.15 (1.56-2.96)	<0.001
Sedentary behaviour	1.05 (0.70-1.58)	0.810	1.08 (0.79-1.48)	0.617
Physical activity				
Low	1 (Reference)		1 (Reference)	
Moderate	0.88 (0.56-1.37)	0.563	0.90 (0.65-1.26)	0.543
High	0.72 (0.44-1.18)	0.197	0.57 (0.38-0.84)	0.005
Smoking tobacco				
Never	1 (Reference)		1 (Reference)	
Past	1.43 (0.83-1.45)	0.193	1.19 (0.75-1.86)	0.466
Current	1.11 (0.69-1.78)	0.670	1.41 (0.98-2.03)	0.064
Need indicators				
Elevated total cholesterol	1.54 (1.05-2.24)	0.026	1.55 (1.17-2.06)	0.002
Heart attack or stroke	0.94 (0.51-1.72)	0.838	1.81 (1.13-2.92)	0.015
Hypertension	1.39 (0.96-2.03)	0.084	1.43 (0.99-2.07)	0.056
Body mass index				
<25 kg/m^2	1 (Reference)		1 (Reference)	
Overweight	0.93 (0.58-1.51)	0.775	1.17 (0.74-1.83)	0.500
Obesity	1.07 (0.64-1.79)	0.801	1.14 (0.75-1.75)	0.548

CI=Confidence Intervals; ARRR=Adjusted Relative Risk Ratio.

Associations with UT2D versus DT2D

In the adjusted logistic regression model, higher education (AOR: 2.02, 95% CI: 1.21-3.37) was positively, 50 years and older (AOR: 0.12, 95% CI: 0.06-0.25), health care advice (AOR: 0.45, 95% CI: 0.29-0.70), and history of cholesterol tests (AOR: 0.37, 95% CI: 0.24-0.58) were negatively associated with UT2D versus DT2D (see Table 4).

Table 4: Associations with undiagnosed type 2 diabetes (UT2D) versus diagnosed (DT2D) in adults in Iraq, 2015

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI) [a]	p-value
Predisposing indicators				
Sex				
Female	1 (Reference)		---	
Male	1.13 (0.77-1.68)	0.524		
Age in years				
18-34	1 (Reference)		1 (Reference)	
35-49	0.12 (0.06 to 0.24)	<0.001	0.23 (0.11-0.46)	<0.001
50 or more	0.05 (0.03 to 0.11)	<0.001	0.12 (0.06-0.25)	<0.001
Marital status				
Not married	1 (Reference)		1 (Reference)	
Married	0.62 (0.39-0.98)	0.034	0.63 (0.37-1.06)	0.079
Enabling/disabling indicators				
Education				
<Primary	1 (Reference)		1 (Reference)	
Primary	1.29 (0.81-2.06)	0.276	0.93 (0.56-1.54)	0.767
>Primary	2.12 (1.32-3.38)	0.002	2.02 (1.21-3.37)	0.007
History of cholesterol screening				
No	1 (Reference)		1 (Reference)	
Yes	0.20 (0.13-0.29)	<0.001	0.37 (0.24-0.58)	<0.001
Health care advice				
No	1 (Reference)		1 (Reference)	
Yes	0.33 (0.22-0.50)	<0.001	0.45 (0.29-0.70)	<0.001
Residence				
Rural	1 (Reference)		---	
Urban	0.79 (0.45-1.38)	0.406		
Sedentary behaviour	0.75 (0.48-1.17)	0.202	---	
Physical activity				
Low	1 (Reference)		1 (Reference)	
Moderate	1.04 (0.62-1.75)	0.869	0.76 (0.45-1.30)	0.319
High	2.13 (1.19-3.80)	0.011	1.18 (0.66-2.13)	0.573

Smoking tobacco				
Never	1 (Reference)		---	
Past	0.61 (0.35-1.04)	0.068		
Current	0.88 (0.51-1.51)	0.641		
Need indicators				
Elevated total cholesterol	0.61 (0.40-0.91)	0.017	0.76 (0.50-1.16)	0.205
Stroke or heart attack	0.18 (0.10-0.34)	<0.001	0.52 (0.26-1.05)	0.067
Hypertension	0.34 (0.23-0.50)	<0.001	0.82 (0.52-1.30)	0.393
Body mass index				
<25 kg/m^2	1 (Reference)		1 (Reference)	
Overweight	0.43 (0.24-0.78)	0.005	0.68 (0.37-1.26)	0.221
Obesity	0.38 (0.23-0.62)	<0.001	0.81 (0.45-1.46)	0.483

[a]Adjusted for all variables in the Table. CI=Confidence Intervals; OR=Odds Ratio.

Discussion

This national survey showed a prevalence of UT2D of 8.1% (47.6% of total T2D), which is higher than global figures (44.7%) [6] and in lower resourced countries (4.9%) [7], and higher than in Suriname (39.6%) [8], in northern Sudan (29.0%) [9], and China (6.9%, 63.3% of total T2D) [11], but lower than in Basrah, Iraq (11.0%) [10]. In people with UT2D versus DT2D fewer diabetes-related comorbidities were observed, including the absence of obesity and hypertension as well as younger age. This finding may be explained by people with UT2D often at an earlier phase of T2D being generally heathier and younger than those with DT2D [12].

According to previous studies [13,16-20,24], the predisposing indicator of increasing age was associated with UT2D versus no T2D. In addition, in unadjusted analysis, not married increased the odds of UT2D versus DT2D, which agrees with some previous studies [17,22].

Consistent with some research [12,17,29], the disabling or enabling indicators higher education, high physical activity, no history of cholesterol testing and no recent health care advice (to lose weight) were associated with UT2D versus DT2D. Participants who use health care services more often through, for example, cholesterol testing and receiving health advice have greater chances of being screened for T2D and can become DT2D [13]. Furthermore, compared to UT2D patients DT2D patients are expected to visit their health care provider more often according to the T2D management guidelines in Iraq [17,41]. Consistent with some findings [18,21], we found that higher education was associated with UT2D versus DT2D. Unlike some previous research [13,15], this survey did not show a significant association

between urban residence and DT2D. This could mean that rural adults have similar access to health services and similar risk factors for T2D than urban adults in Iraq.

In agreement with previous studies [13,26,32,33], need indicators (perceived need for health services) in terms of high cholesterol was associated with UT2D. Some previous research [15,16,18-20,25,26,30-32] showed a correlation between hypertension and obesity with UT2D versus no T2D, while we found negative associations with UT2D versus DT2D. Only cardiovascular disease was positively associated with DT2D, which again may be explained by a higher likelihood of being screened for T2D when attending to health care for cardiovascular disease management.

Study strengths and limitations

Study strengths included the use of standardized STEPS assessment measures and the inclusion of a nationally representative sample of all adult ages. However, institutionalized adults were excluded from the survey. The study was limited due to its cross-sectional design, the dated data, the use of some self-reported measures, and non-inclusion of some potentially relevant variables, such as family history and awareness of diabetes.

Public health implications

Intensified efforts are needed to increase awareness and screen for T2D in Iraq. The Iraq national non-communicable diseases policy emphasizes public awareness campaigns, screening, early diagnosis, and integrated care of T2D, strengthening the capacities of health workers in primary health care centres to provide advice regarding early detection of diabetes, and inclusion for first-line treatment for diabetes as essential medicines list for primary health care centres [42]. In addition, an expert panel recommended further screening for diabetes and pre-diabetes across the various regions of Iraq, and that the Finnish Diabetes Risk Score (FINDRISC) is an appropriate screening tool for T2DM that should be made available to all asymptomatic patients across the country [41].

Conclusion

Almost one in ten adults in Iraq had UT2D. Predisposing indicators, such as increasing age, and need indicators or perceived need for health services, such as high cholesterol, were identified as

associated with UT2D versus no T2D, and decreasing age, higher education, and low health care service use in terms of health care advice and cholesterol testing, were found to increase the odds of UT2D versus DT2D, which can be included in improving uptake of early T2D detection.

Contributors

Both authors fulfil the criteria for authorship. SP and KP conceived and designed the research, performed statistical analysis, drafted the manuscript and made critical revision of the manuscript for key intellectual content. Both authors read and approved the final version of the manuscript and have agreed to authorship and order of authorship for this manuscript.

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Competing interests

None declared.

Data availability statement

The data source is publicly available at the World Health Organization NCD Microdata Repository (URL: https://extranet.who.int/ncdsmicrodata/index.php/catalog).

Ethical approval Ethics approval for the STEPS survey was obtained from the Republic of Iraq Ministry of Health/Environment Public Health Directorate. No additional approval was needed for the present secondary analysis.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2	
Objectives	3	State specific objectives, including any prespecified hypotheses	3	
Methods				
Study design	4	Present key elements of study design early in the paper	4	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4	
Participants	6	a) ***Cohort study***—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up b) ***Case-control study***—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls c) ***Cross-sectional study***—Give the eligibility criteria, and the sources and methods of selection of participants	4	
		d) ***Cohort study***—For matched studies, give matching criteria and number of exposed and unexposed *e)* ***Case-control study***—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5	
Bias	9	Describe any efforts to address potential sources of bias	5	

STROBE Checklist

Study size	10	Explain how the study size was arrived at	5	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding		
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		
		(*b*) Report category boundaries when continuous variables were categorized		

STROBE Checklist

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		
Generalisability	21	Discuss the generalisability (external validity) of the study results		
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		

***Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.**