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

Supa Pengpid,[1,2,3] Karl Peltzer [1,4,5]

**To cite:** Pengpid S, Peltzer K. Prevalence and factors associated with undiagnosed type 2 diabetes among adults in Iraq: analysis of cross-sectional data from the 2015 STEPS survey. *BMJ Open* 2022;**12**:e064293. doi:10.1136/bmjopen-2022-064293

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-064293).

Received 27 April 2022
Accepted 10 November 2022



[1]Department of Health Education and Behavioral Sciences, Faculty of Public Health, Mahidol University, Bangkok, Thailand
[2]Department of Public Health, Sefako Makgatho Health Sciences University, Pretoria, South Africa
[3]Department of Healthcare Aministration, College of Medical and Health Science, Asia University, Taichung, Taiwan
[4]Department of Psychology, University of the Free State, Bloemfontein, South Africa
[5]Department of Psychology, College of Medical and Health Science, Asia University, Taichung, Taiwan

**Correspondence to**
Dr Karl Peltzer;
kfpeltzer@gmail.com

## 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 3853 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 (adjusted relative risk ratio (ARRR): 2.11, 95% CI 1.30 to 3.43) and those with high cholesterol (ARRR: 1.54, 95% CI 1.05 to 2.24) had a higher risk of UT2D. Older age (≥50 years) (ARRR: 17.90, 95% CI 8.42 to 38.06), receipt of healthcare advice (ARRR: 2.15, 95% CI 1.56 to 2.96), history of cholesterol testing (ARRR: 2.17, 95% CI 1.58 to 2.99), stroke or heart attack (ARRR: 1.81, 95% CI 1.13 to 2.92), and high cholesterol (ARRR: 1.55, 95% CI 1.17 to 2.06) were positively associated with DT2D, and high physical activity (ARRR: 0.57, 95% CI 0.38 to 0.84) was negatively associated with DT2D. Higher than primary education (adjusted OR (AOR): 2.02, 95% CI 1.21 to 3.37) was positively associated with UT2D versus DT2D, while older age (≥50 years) (AOR: 0.12, 95% CI 0.06 to 0.25), healthcare advice (AOR: 0.45, 95% CI 0.29 to 0.70), and history of cholesterol screening (AOR: 0.37, 95% CI 0.24 to 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.

## 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, emphasising 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 contextualised in terms of issues with healthcare use,[13 14] including predisposing indicators (demographic characteristics), enabling indicators (enabling or limiting factors in relation to usage of healthcare) 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

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

| Variable | Sample | T2D status | | |
|---|---|---|---|---|
| | | No | Undiagnosed | Diagnosed |
| N | 3853 | 3070 | 326 | 457 |
| | N (%) | % | % | % |
| All | | 83 | 8.1 | 8.9 |
| Predisposing indicators | | | | |
| Age in years | | | | |
| 18–34 | 1439 (56.1) | 93.2 | 6 | 0.8 |
| 35–49 | 1271 (23.1) | 79.2 | 9.9 | 10.9 |
| 50 or more | 1132 (20.8) | 60 | 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 |
| Healthcare 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 | 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 | 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 |
| 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 |
| Hypertension | 1652 (35.5) | 71.4 | 10.6 | 18 |
| Heart attack or stroke | 232 (4.3) | 50.1 | 8.3 | 41.6 |
| Elevated total cholesterol | 1443 (33.7) | 74.3 | 10.6 | 15 |

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

| | UT2D | | DT2D | |
|---|---|---|---|---|
| Variable | 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 |
| Healthcare 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 |

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)

| | UT2D | | DT2D | |
|---|---|---|---|---|
| Variable | 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 to 2.43) | 0.034 | 7.67 (3.86 to 15.25) | <0.001 |
| 50 or more | 2.11 (1.30 to 3.43) | 0.003 | 17.90 (8.42 to 38.06) | <0.001 |
| Marital status | | | | |
| Not married | 1 (Reference) | | 1 (Reference) | |
| Married | 1.06 (0.70 to 1.61) | 0.781 | 1.31 (0.90 to 1.89) | 0.156 |
| Enabling/disabling indicators | | | | |
| Education | | | | |
| <Primary | 1 (Reference) | | 1 (Reference) | |
| Primary | 0.99 (0.64 to 1.51) | 0.946 | 0.89 (0.63 to 1.26) | 0.509 |
| >Primary | 1.26 (0.85 to 1.86) | 0.254 | 0.72 (0.50 to 1.04) | 0.079 |
| Ever cholesterol screening | | | | |
| No | 1 (Reference) | | 1 (Reference) | |
| Yes | 0.86 (0.58 to 1.27) | 0.44 | 2.17 (1.58 to 2.99) | <0.001 |
| Healthcare advice (past 3 years) | | | | |
| No | 1 (Reference) | | 1 (Reference) | |
| Yes | 1.03 (0.71 to 1.48) | 0.879 | 2.15 (1.56 to 2.96) | <0.001 |
| Sedentary behaviour | 1.05 (0.70 to 1.58) | 0.81 | 1.08 (0.79 to 1.48) | 0.617 |
| Physical activity | | | | |
| Low | 1 (Reference) | | 1 (Reference) | |
| Moderate | 0.88 (0.56 to 1.37) | 0.563 | 0.90 (0.65 to 1.26) | 0.543 |
| High | 0.72 (0.44 to 1.18) | 0.197 | 0.57 (0.38 to 0.84) | 0.005 |
| Smoking tobacco | | | | |
| Never | 1 (Reference) | | 1 (Reference) | |
| Past | 1.43 (0.83 to 1.45) | 0.193 | 1.19 (0.75 to 1.86) | 0.466 |
| Current | 1.11 (0.69 to 1.78) | 0.67 | 1.41 (0.98 to 2.03) | 0.064 |
| Need indicators | | | | |
| Elevated total cholesterol | 1.54 (1.05 to 2.24) | 0.026 | 1.55 (1.17 to 2.06) | 0.002 |
| Heart attack or stroke | 0.94 (0.51 to 1.72) | 0.838 | 1.81 (1.13 to 2.92) | 0.015 |
| Hypertension | 1.39 (0.96 to 2.03) | 0.084 | 1.43 (0.99 to 2.07) | 0.056 |
| Body mass index | | | | |
| <25 kg/m$^2$ | 1 (Reference) | | 1 (Reference) | |
| Overweight | 0.93 (0.58 to 1.51) | 0.775 | 1.17 (0.74 to 1.83) | 0.5 |
| Obesity | 1.07 (0.64 to 1.79) | 0.801 | 1.14 (0.75 to 1.75) | 0.548 |

ARRR, adjusted relative risk ratio.

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 15–17] healthcare usage 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

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)* | P value |
|---|---|---|---|---|
| Predisposing indicators | | | | |
| Sex | | | | |
| Female | 1 (Reference) | | – | |
| Male | 1.13 (0.77 to 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 to 0.46) | <0.001 |
| 50 or more | 0.05 (0.03 to 0.11) | <0.001 | 0.12 (0.06 to 0.25) | <0.001 |
| Marital status | | | | |
| Not married | 1 (Reference) | | 1 (Reference) | |
| Married | 0.62 (0.39 to 0.98) | 0.034 | 0.63 (0.37 to 1.06) | 0.079 |
| Enabling/disabling indicators | | | | |
| Education | | | | |
| <Primary | 1 (Reference) | | 1 (Reference) | |
| Primary | 1.29 (0.81 to 2.06) | 0.276 | 0.93 (0.56 to 1.54) | 0.767 |
| >Primary | 2.12 (1.32 to 3.38) | 0.002 | 2.02 (1.21 to 3.37) | 0.007 |
| History of cholesterol screening | | | | |
| No | 1 (Reference) | | 1 (Reference) | |
| Yes | 0.20 (0.13 to 0.29) | <0.001 | 0.37 (0.24 to 0.58) | <0.001 |
| Healthcare advice | | | | |
| No | 1 (Reference) | | 1 (Reference) | |
| Yes | 0.33 (0.22 to 0.50) | <0.001 | 0.45 (0.29 to 0.70) | <0.001 |
| Residence | | | | |
| Rural | 1 (Reference) | | – | |
| Urban | 0.79 (0.45 to 1.38) | 0.406 | | |
| Sedentary behaviour | 0.75 (0.48 to 1.17) | 0.202 | – | |
| Physical activity | | | | |
| Low | 1 (Reference) | | 1 (Reference) | |
| Moderate | 1.04 (0.62 to 1.75) | 0.869 | 0.76 (0.45 to 1.30) | 0.319 |
| High | 2.13 (1.19 to 3.80) | 0.011 | 1.18 (0.66 to 2.13) | 0.573 |
| Smoking tobacco | | | | |
| Never | 1 (Reference) | | – | |
| Past | 0.61 (0.35 to 1.04) | 0.068 | | |
| Current | 0.88 (0.51 to 1.51) | 0.641 | | |
| Need indicators | | | | |
| Elevated total cholesterol | 0.61 (0.40 to 0.91) | 0.017 | 0.76 (0.50 to 1.16) | 0.205 |
| Stroke or heart attack | 0.18 (0.10 to 0.34) | <0.001 | 0.52 (0.26 to 1.05) | 0.067 |
| Hypertension | 0.34 (0.23 to 0.50) | <0.001 | 0.82 (0.52 to 1.30) | 0.393 |
| Body mass index | | | | |
| <25 kg/m$^2$ | 1 (Reference) | | 1 (Reference) | |
| Overweight | 0.43 (0.24 to 0.78) | 0.005 | 0.68 (0.37 to 1.26) | 0.221 |
| Obesity | 0.38 (0.23 to 0.62) | <0.001 | 0.81 (0.45 to 1.46) | 0.483 |

*Adjusted for all variables in the table.

(≥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 1 month residing in Iraq and exclusion criteria were temporary residence, displaced and institutionalised adults.[36] Following the STEPS survey procedures, data collection included three steps: (1) social and behavioural information, (2)

physical and blood pressure (BP) and (3) biochemical measurements.[35] Blood glucose, total cholesterol (TC) and triglycerides were measured in peripheral (capillary) blood at the data collection site using dry chemical methods, biochemical analysis and automated analyser.[36]

### 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; diagnosed T2D (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

Healthcare advice, history of cholesterol testing, sedentary behaviour, physical activity and smoking history. Healthcare advice included, 'During the past 3 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.[37 38]

#### Need indications

High TC, 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 ≥140 mm Hg and/or diastolic BP ≥90 mm Hg 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 TC: being on antilipidemic medication or having elevated TC: ≥5.17 mmol/L (200 mg/dL).[40]

#### Statistical analysis

All statistical analyses were conducted with STATA software V.14.0 (Stata Corporation) 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 3853 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.

### Associations with UT2D and DT2D versus no diabetes

In the final adjusted model, 50 years and older (adjusted relative risk ratio (ARRR): 2.11, 95% CI 1.30 to 3.43) and high cholesterol (ARRR: 1.54, 95% CI 1.05 to 2.24) were positively associated with UT2D. Participants ≥50 years and older (ARRR: 17.90, 95% CI 8.42 to 38.06), received advice from the healthcare provider (ARRR: 2.15, 95% CI 1.56 to 2.96), history of cholesterol testing (ARRR: 2.17, 95% CI 1.58 to 2.99), stroke or heart attack (ARRR: 1.81, 95% CI 1.13 to 2.92) and high cholesterol (ARRR: 1.55, 95% CI 1.17 to 2.06) were positively associated with DT2D, and high physical activity (ARRR: 0.57, 95% CI 0.38 to 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).

### Associations with UT2D versus DT2D

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

## 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 healthier 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 healthcare advice (to lose weight) were associated with

UT2D versus DT2D. Participants who use healthcare 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 with UT2D patients DT2D patients are expected to visit their healthcare 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 healthcare for cardiovascular disease management.

### Study strengths and limitations

Study strengths included the use of standardised STEPS assessment measures and the inclusion of a nationally representative sample of all adult ages. However, institutionalised 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 emphasises public awareness campaigns, screening, early diagnosis and integrated care of T2D, strengthening the capacities of health workers in primary healthcare centres to provide advice regarding early detection of diabetes, and inclusion for first-line treatment for diabetes as essential medicines list for primary healthcare 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 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 healthcare service use in terms of healthcare 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.

**Acknowledgements** "This paper uses data from the Global School-Based Student Health Survey (GSHS). GSHS is supported by the World Health Organization and the US Centers for Disease Control and Prevention."

**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. KP is the guarantor accepting full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Consent obtained directly from patient(s).

**Ethics approval** 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 anonymised data from STEPS in the present analysis.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available in a public, open access repository. The data source is publicly available at the WHO NCD Microdata Repository (URL: https://extranet.who.int/ncdsmicrodata/index.php/catalog).



**ORCID iD**

Karl Peltzer http://orcid.org/0000-0002-5980-0876

## REFERENCES

1 World Health Organization (WHO). Diabetes factsheet, 2021. Available: https://www.who.int/news-room/fact-sheets/detail/diabetes [Accessed 05 Feb 2022].
2 Fowler MJ. Microvascular and macrovascular complications of diabetes. *Clin Diabetes* 2011;29:116–22.
3 Vinik A, Flemmer M. Diabetes and macrovascular disease. *J Diabetes Complications* 2002;16:235–45.
4 Wild SH, Smith FB, Lee AJ, *et al*. Criteria for previously undiagnosed diabetes and risk of mortality: 15-year follow-up of the Edinburgh artery study cohort. *Diabet Med* 2005;22:490–6.
5 Valdés S, Botas P, Delgado E, *et al*. Mortality risk in Spanish adults with diagnosed diabetes, undiagnosed diabetes or pre-diabetes. The asturias study 1998-2004. *Rev Esp Cardiol* 2009;62:528–34.
6 Ogurtsova K, Guariguata L, Barengo NC, *et al*. IDF diabetes atlas: global estimates of undiagnosed diabetes in adults for 2021. *Diabetes Res Clin Pract* 2022;183:109118.
7 Seiglie JA, Marcus M-E, Ebert C, *et al*. Diabetes prevalence and its relationship with education, wealth, and BMI in 29 low- and middle-income countries. *Diabetes Care* 2020;43:767–75.
8 Krishnadath ISK, Nahar-van Venrooij LM, Jaddoe VWV, *et al*. Ethnic differences in prediabetes and diabetes in the Suriname health study. *BMJ Open Diabetes Res Care* 2016;4:e000186.
9 Eltom MA, Babiker Mohamed AH, Elrayah-Eliadarous H, *et al*. Increasing prevalence of type 2 diabetes mellitus and impact of ethnicity in North Sudan. *Diabetes Res Clin Pract* 2018;136:93–9.
10 Mansour AA, Al-Maliky AA, Kasem B, *et al*. Prevalence of diagnosed and undiagnosed diabetes mellitus in adults aged 19 years and older in Basrah, Iraq. *Diabetes Metab Syndr Obes* 2014;7:139–44.

11 Wang L, Gao P, Zhang M, *et al*. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. *JAMA* 2017;317:2515–23.
12 Mansour AA, Wanoose HL, Hani I, *et al*. Diabetes screening in Basrah, Iraq: a population-based cross-sectional study. *Diabetes Res Clin Pract* 2008;79:147–50.
13 Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav* 1995;36:1–10.
14 Mou C, Xu M, Lyu J. Predictors of undiagnosed diabetes among middle-aged and seniors in China: application of Andersen's behavioral model. *Int J Environ Res Public Health* 2021;18:8396.
15 Lee S, Washburn DJ, Colwell B, *et al*. Examining social determinants of undiagnosed diabetes in Namibia and South Africa using a behavioral model of health services use. *Diabetes Res Clin Pract* 2021;175:108814.
16 Claypool KT, Chung M-K, Deonarine A, *et al*. Characteristics of undiagnosed diabetes in men and women under the age of 50 years in the Indian subcontinent: the National Family Health Survey (NFHS-4)/Demographic Health Survey 2015-2016. *BMJ Open Diabetes Res Care* 2020;8:e000965.
17 Du Y, Baumert J, Paprott R, *et al*. Factors associated with undiagnosed type 2 diabetes in Germany: results from German health interview and examination survey for adults 2008-2011. *BMJ Open Diabetes Res Care* 2020;8:e001707.
18 Islam RM, Magliano DJ, Khan MN, *et al*. Prevalence of undiagnosed diabetes and the relative importance of its risk factors among adults in Bangladesh: findings from a nationwide survey. *Diabetes Res Clin Pract* 2022;185:109228.
19 Heltberg A, Andersen JS, Sandholdt H, *et al*. Predictors of undiagnosed prevalent type 2 diabetes – the Danish General suburban population study. *Prim Care Diabetes* 2018;12:13–22.
20 Mohammad A, Ziyab AH, Mohammad T. Prevalence of prediabetes and undiagnosed diabetes among Kuwaiti adults: a cross-sectional study. *Diabetes Metab Syndr Obes* 2021;14:2167–76.
21 Hasan MM, Tasnim F, Tariqujjaman M, *et al*. Socioeconomic inequalities of undiagnosed diabetes in a resource-poor setting: insights from the cross-sectional Bangladesh demographic and health survey 2011. *Int J Environ Res Public Health* 2019;16:115.
22 Heianza Y, Arase Y, Kodama S, *et al*. Association of living alone with the presence of undiagnosed diabetes in Japanese men: the role of modifiable risk factors for diabetes: Toranomon Hospital health management center study 13 (topics 13). *Diabet Med* 2013;30:1355–9.
23 Hsueh L, Wu W, Hirsh AT, *et al*. Undiagnosed diabetes among immigrant and racial/ethnic minority adults in the United States: National health and nutrition examination survey 2011-2018. *Ann Epidemiol* 2020;51:14–19.
24 Coppell KJ, Mann JI, Williams SM, *et al*. Prevalence of diagnosed and undiagnosed diabetes and prediabetes in New Zealand: findings from the 2008/09 adult nutrition survey. *N Z Med J* 2013;126:23–42.
25 Bantie GM, Wondaye AA, Arike EB, *et al*. Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of Bahir Dar City, Northwest Ethiopia: a community-based cross-sectional study. *BMJ Open* 2019;9:e030158.
26 O Connor JM, Millar SR, Buckley CM, *et al*. The prevalence and determinants of undiagnosed and diagnosed type 2 diabetes in middle-aged Irish adults. *PLoS One* 2013;8:e80504.
27 Walker RJ, Garacci E, Ozieh M, *et al*. Food insecurity and glycemic control in individuals with diagnosed and undiagnosed diabetes in the United States. *Prim Care Diabetes* 2021;15:813–8.
28 Ruiz PL-D, Hopstock LA, Eggen AE, *et al*. Undiagnosed diabetes based on $HbA_{1c}$ by socioeconomic status and healthcare consumption in the Tromsø Study 1994-2016. *BMJ Open Diabetes Res Care* 2021;9:e002423.
29 Leahy S, O' Halloran AM, O' Leary N, *et al*. Prevalence and correlates of diagnosed and undiagnosed type 2 diabetes mellitus and pre-diabetes in older adults: findings from the Irish longitudinal study on ageing (TILDA). *Diabetes Res Clin Pract* 2015;110:241–9.
30 Pramono LA, Setiati S, Soewondo P, *et al*. Prevalence and predictors of undiagnosed diabetes mellitus in Indonesia. *Acta Med Indones* 2010;42:216–23.
31 Nguyen VD, Vien QM, Do TH, *et al*. Prevalence of undiagnosed diabetes and pre-diabetes and its associated risk factors in Vietnam. *J Glob Health Sci* 2019;1:e7.
32 Bjarkø VV, Haug EB, Sørgjerd EP, *et al*. Undiagnosed diabetes: prevalence and cardiovascular risk profile in a population-based study of 52,856 individuals. The HUNT study, Norway. *Diabet Med* 2022;39:e14829.
33 Apidechkul T, Chomchoei C, Upala P. Epidemiology of undiagnosed type 2 diabetes mellitus among Hill tribe adults in Thailand. *Sci Rep* 2022;12:3969.
34 World Health Organization (WHO). NCD Microdata Repository, 2015. Iraq - STEPS. Available: https://extranet.who.int/ncdsmicrodata/index.php/catalog/420 [Accessed 10 Nov 2021].
35 World Health Organization (WHO). Stepwise approach to surveillance (steps), 2018. Available: https://www.who.int/ncds/surveillance/steps/en/ [Accessed 22 Aug 2021].
36 Ministry of Health, Iraq Ministry of Planning and Development Cooperation, World Health Organization. Noncommunicable diseases risk factors steps survey Iraq, 2015. Available: http:// www.who.int/chp/steps/Iraq_2015_STEPS_Report.pdf?ua=1 [Accessed 10 Oct 2021].
37 Armstrong T, Bull F. Development of the world Health organization global physical activity questionnaire (GPAQ). *J Public Health* 2006;14:66–70.
38 Ekelund U, Steene-Johannessen J, Brown WJ, *et al*. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet* 2016;388:1302–10.
39 Chobanian AV, Bakris GL, Black HR, *et al*. Seventh report of the joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. *Hypertension* 2003;42:1206–52.
40 Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive summary of the third report of the National cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). *JAMA* 2001;285:2486–97.
41 Abusaib M, Ahmed M, Nwayyir HA, *et al*. Iraqi experts consensus on the management of type 2 diabetes/prediabetes in adults. *Clin Med Insights Endocrinol Diabetes* 2020;13:117955142094223.
42 Ministry of Health. Iraq_The national strategy for prevention and control of noncommunicable diseases-2013-2017. Available: https://extranet.who.int/nutrition/gina/en/node/24448