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 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 4.82 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.

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,18-20 lower among age ≥70 years vs 35–39 years21), male sex,16-18 living alone,17,22 marital or cohabitation status,22 ethnic minority,23 ethnicity,24 and

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.
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 | 8.3         | 8.9       |
| **Predisposing indicators**   |        |     |             |           |
| Age in years                  |        |     |             |           |
| 18–34                         | 1439   | 93.2 | 6           | 0.8       |
| 35–49                         | 1271   | 79.2 | 9.2         | 10.9      |
| 50 or more                    | 1132   | 60   | 11.5        | 28.5      |
| Sex                           |        |     |             |           |
| Female                        | 2331   | 82.8 | 7.9         | 9.3       |
| Male                          | 1522   | 83.3 | 8.2         | 8.5       |
| Marital status                |        |     |             |           |
| Not married                   | 948    | 87.5 | 7.1         | 5.4       |
| Married                       | 2900   | 80.9 | 8.5         | 10.6      |
| **Enabling/disabling factors**|        |     |             |           |
| Residence                     |        |     |             |           |
| Rural                         | 838    | 82.8 | 8.9         | 8.3       |
| Urban                         | 3015   | 83.1 | 7.8         | 9.1       |
| Healthcare advice (past 3 years) |    |     |             |           |
| No                            | 2050   | 87.3 | 8.1         | 4.7       |
| Yes                           | 1802   | 77.9 | 8.1         | 14.1      |
| Ever cholesterol screening    |        |     |             |           |
| No                            | 2888   | 87.3 | 8           | 4.7       |
| Yes                           | 965    | 67.3 | 8.2         | 24.5      |
| Education                     |        |     |             |           |
| <Primary                      | 1690   | 79.7 | 8.2         | 12.1      |
| Primary                       | 979    | 84.5 | 7.2         | 8.3       |
| >Primary                      | 1164   | 85.6 | 8.5         | 5.9       |
| Smoking tobacco               |        |     |             |           |
| Never                         | 2929   | 84.5 | 7.7         | 7.8       |
| Past                          | 304    | 68.6 | 11.8        | 19.6      |
| Current                       | 620    | 82.9 | 8           | 9.1       |
| Physical activity             |        |     |             |           |
| Low                           | 2158   | 80.4 | 8.8         | 10.9      |
| Moderate                      | 886    | 81.4 | 8.5         | 10.1      |
| High                          | 805    | 90.3 | 6.1         | 3.6       |
| Sedentary behaviour           | 1092   | 78.9 | 9.1         | 12        |
| **Need indicators**           |        |     |             |           |
| Body mass index               |        |     |             |           |
| <25 kg/m²                     | 958    | 89.5 | 6.8         | 3.7       |
| Overweight                    | 1219   | 82.4 | 7.8         | 9.8       |
| Obesity                       | 1560   | 76.3 | 9.7         | 14        |
| Hypertension                  | 1652   | 71.4 | 10.6        | 18        |
| Heart attack or stroke        | 232    | 50.1 | 8.3         | 41.6      |
| Elevated total cholesterol    | 1443   | 74.3 | 10.6        | 15        |
| 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 |
| **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/m² | 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.
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, including those with fasting blood glucose values (response rate 93.0%). 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 1 month residing in Iraq and exclusion criteria were temporary residence, displaced and institutionalised adults. Following the STEPS survey procedures, data collection included three steps: (1) social and behavioural information, (2)

### 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/m²                    | 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.
physical and blood pressure (BP) and (3) biochemical measurements.\textsuperscript{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.\textsuperscript{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 \(\geq 126\, \text{mg/dL}\); 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?’\textsuperscript{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.\textsuperscript{36} Physical activity levels (low, moderate and high) and sedentary behaviour ( \(\geq 28\) hours sitting/day) were measured with the Global Physical Activity Questionnaire.\textsuperscript{37,38}

**Need indications**

High TC, stroke or heart attack, hypertension and body mass index (BMI). Definitions were as follows:

- BMI: underweight (<18.5 \(\text{kg/m}^2\)), normal weight (18.5–24.9 \(\text{kg/m}^2\)), overweight (25.0–29.9 \(\text{kg/m}^2\)) and obesity (\(\geq 30.0\, \text{kg/m}^2\))\textsuperscript{35};
- hypertension: systolic BP \(\geq 140\, \text{mm Hg}\) and/or diastolic BP \(\geq 90\, \text{mm Hg}\) and/or previously or current treatment with antihypertensive drugs\textsuperscript{36};
- 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)\textsuperscript{36};
- elevated TC: on antilipidemic medication or having elevated TC: \(\geq 5.17\, \text{mmol/L (200 mg/dL)}\).\textsuperscript{40}

**Statistical analysis**

All statistical analyses were conducted with STATA software V14.0 (Stata Corporation) by taking the complex study design into account.\textsuperscript{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 \(\geq 50\) 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%)\textsuperscript{2} and in lower resourced countries (4.9%),\textsuperscript{7} and higher than in Suriname (39.6%),\textsuperscript{8} in northern Sudan (29.0%),\textsuperscript{9} and China (6.9%, 63.3% of total T2D),\textsuperscript{11} but lower than in Basrah, Iraq (11.0%).\textsuperscript{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.\textsuperscript{12}

According to previous studies,\textsuperscript{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.\textsuperscript{17,22}

Consistent with some research,\textsuperscript{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. Furthermore, compared with UT2D patients DT2D patients are expected to visit their healthcare provider more often according to the T2D management guidelines in Iraq. Consistent with some findings, we found that higher education was associated with UT2D versus DT2D. Unlike some previous research, 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, need indicators (perceived need for health services) in terms of high cholesterol was associated with UT2D. Some previous research 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. 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.

**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.

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**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/ncdmsicrodata/index.php/catalog).

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