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Ethnicity is an independent risk indicator when estimating diabetes risk with FINDRISC scores; A cross sectional study comparing immigrants from the Middle East and native Swedes

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Abstract:

Aims: This study sought to compare type 2 diabetes (T2D) risk indicators in Iraqi immigrants with those in ethnic Swedes living in southern Sweden.

Methods: Population-based, cross-sectional cohort study of men and women, aged 30–75 years, born in Iraq or Sweden conducted in 2010–2012 in Malmö, Sweden. A 75 g oral glucose tolerance test was performed and sociodemographic and lifestyle data were collected. T2D risk was assessed by the Finnish Diabetes Risk Score (FINDRISC).

Results: In Iraqi versus Swedish participants, T2D was twice as prevalent (11.6 vs. 5.8%, $p<0.001$). A large proportion of the excess T2D risk was attributable to larger waist circumference and first-degree family history of diabetes. However, Iraqi ethnicity was a risk factor for T2D independently of other FINDRISC factors (odds ratio 2.5, 95% CI 1.6-3.9). The FINDRISC algorithm predicted that more Iraqis than Swedes (16.2 vs. 12.3%, $p<0.001$) will develop T2D within the next decade. The total annual costs for excess T2D risk in Iraqis are estimated to exceed 2.3 million euros (2005), not accounting for worse quality of life.

Conclusions:

Our study suggests that Middle Eastern ethnicity should be considered an independent risk indicator for diabetes. Accordingly, the implementation of culturally tailored prevention programs may be warranted.

Keywords: type 2 diabetes, incidence, prevalence, Middle East, FINDRISC

Background

Type 2 diabetes (T2D) is one of the strongest risk factors for cardiovascular disease and premature death [1]. The prevalence of T2D is continuously increasing worldwide, and it is estimated that by 2025 that 15% of the global population will be affected by T2D, impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) [2].

Of the five countries with the highest diabetes prevalence, four are located in the Middle East, where overall prevalence rates vary between 7 and 20% [3, 4]. Migration and urbanization are known risk factors for T2D [5] and epidemiological studies have shown that immigrants from the Middle East have a high prevalence of T2D, which is partly thought to be a consequence of obesity (body mass index, BMI≥30 kg/m^2), which is highly prevalent in non-European immigrants [6]. Considering the risk of reduced quality of life[7] and of diabetic complications and early death, determining the metabolic, lifestyle and heritable risk factors that underlie the high diabetes prevalence in immigrant populations from the Middle East is of high priority.

The total annual diabetes-related costs for healthcare, productivity loss, lost life-years and lost productivity years (as a result of mortality or permanent disability) was roughly 920 million euros (mEUR) in 2005, more than twice the expenditure in 1987 (439 mEUR), owing largely to a sharp increase in the disease's prevalence [8]. Thus, there are substantial health incentives as well as economic incentives to detect and prevent from the development of diabetes, especially in high-risk populations. Moreover, as highlighted in a recent systematic review [9], there is a relative dearth of such studies, particularly in immigrant communities.

The purpose of the current study was to determine and compare the prevalence of T2D and the frequency of intermediate risk factors for T2D in Middle Eastern immigrants to Sweden and ethnic Swedes living within the same region of southern Sweden. This study also sought to estimate and compare the future burden and incidence of diabetes in these populations using the

Finnish Diabetes Risk Score, FINDRISC [10], which was developed as a population screening tool for Nordic populations [10].

Methods and procedures

In the MEDIM study (the impact of Migration and Ethnicity on Diabetes In Malmö) citizens of Malmö born in Iraq or Sweden 30 to 75 years of age were randomly selected from the census register and invited by mail and phone to participate in this population-based survey. We aimed to recruit Iraqi and Swedish groups matched for sex and 10-year age distributions (2:1 matching). People with type 1 diabetes, severe physical or mental illness or disabilities were not included in the study. Participants included second-generation immigrants born in Sweden. All participants fulfilling the inclusion criteria were enrolled consecutively in the survey as they accepted to participate and no individuals were excluded due to inconsistent matching with age group.

To minimize cohort effects and assessment biases, examinations were conducted within a relatively short timeframe (February 1, 2010 through December 31, 2012). Figure 1 shows a flow chart describing the recruitment of MEDIM participants.

Power and sample size calculation

Power calculation was based on estimations on differences in T2D in an adult Swedish and Iraqi population. We estimated that the T2D prevalence would be 7% in a Middle Eastern population and 4% in native Swedes [5]. With alpha=0.05 (two sided test) and a power of 80% we would detect a significant difference in T2D prevalence with a sample size of 1400 participants born in Iraq and 1400 born in Sweden. However, the study was stopped in advance since T2D prevalence was higher than estimated amongst Iraqis; with these differences in prevalence, the sample size yielded an estimated power of 99% to determine that this difference was statistically significant.

Ethical considerations

All participants provided written informed consent and the Ethics Committee at Lund University approved the study (No. 2009/36 & 2010/561). This investigation conforms to the principles outlined in the Declaration of Helsinki [11].

Physical examination

Trained Swedish and Arabic speaking research nurses conducted standard physical examinations. Assessment of standard physical examinations and clinical variables such as blood pressure, height, weight, body mass index (BMI) and waist circumference was performed as described previously [12].

Blood samples and oral glucose tolerance test (OGTT)

Participants were instructed not to eat or drink nothing but water or consume tobacco later than 10 pm the day before the OGTT and to bring a record of their current medications. The following morning a 75g oral glucose tolerance test (OGTT) was performed. Blood samples were collected prior to the glucose load and at 30, 60, 90 and 120 minutes; glucose was analyzed continuously on fresh plasma from venous whole blood immediately after sampling using a photometer (HemoCue AB, Ängelholm, Sweden) as described previously [12]. New cases of diabetes were confirmed by fasting plasma glucose level of ≥7.0 mmol/L and/or by a 2-h plasma glucose level of ≥11.1 mmol/L. Two pathological values were needed for diagnosis [13] and if only one glucose value was indicative of diabetes, the OGTT was repeated another day with the same fasting procedures. Participants stating they had existing diabetes, were considered as previously

diagnosed diabetes cases if they were on medication with oral hypoglycaemic agents and/or insulin or if they had fasting glucose ≥7.0 mmol/l. Participants with previously known diabetes did not undergo an OGTT.

Impaired fasting glucose (IFG) was defined as a fasting plasma glucose level of ≥6.1 mmol/L and <7.0 mmol/L and a 2-h plasma glucose level of <7.8 mmol/L[13]. Impaired glucose tolerance (IGT) was defined as a fasting plasma glucose level of <6.1 mmol/L and a 2-h plasma glucose level of ≥7.8 mmol/L and <11.1 mmol/L [13] and impaired glucose regulation (IGR) was defined as IFG in combination with IGT.

Questionnaires

Information on lifestyle habits, family history of diabetes, previous diagnosis of diabetes, present medication and family history of diabetes (in biological parents and/or siblings) and sociodemography was collected through interviews conducted by Arabic and Swedish speaking nurses using structured questionnaires in Swedish and Arabic as described previously [12]. All questionnaires were translated and back-translated by two independent professional translators with Arabic as their native language [12].

The Finnish Diabetes Risk Score, FINDRISC

FINDRISC estimates the risk of developing diabetes within the next 10 years[10]. The scores are based on age, anthropometrical measures such as BMI and waist circumference, family history of diabetes in second- or first degree biological relatives, lifestyle factors such as physical activity and intake of fruit and vegetables, history of gestational diabetes and medication for hypertension.

Diabetes risk was assessed according to FINDRISC scores (http://www.diabetes.fi/files/1100/Type2diabetesRiskTest_.jpg). Risk estimates for diabetes within the next decade are according to FINDRISC: low risk <7 points (p), 1 in 100 develop diabetes; slightly elevated risk 7 to 11p, 1 in 25 develop diabetes; moderate risk 12 to 14p, 1 in 6 develop diabetes; high risk 15 to 20p, 1 in 3 develop diabetes and very high risk ≥21 p, 1 in 2 develop diabetes within the next decade [10]. Participants with IGT or IGR were also considered being at very high risk [14, 15].

The following risk factors were assessed in the FINDRISC form:

Age: <45 years (0p); 45 to 54 years (2p); 55 to 64 years (3p); >64 years (4p).

BMI: <25 kg/m^2 (0p), 25 to 30 kg/m^2 (1p); >30 kg/m^2 (3p);

Waist circumference: men<94 cm, women<80 cm (0p); men 94 to 102 cm, women 80 to 88 cm (3p); men>102 cm women> 88 cm (4p).

Do you usually have daily at least 30 minutes of physical activity at work and/or during leisure time (including normal daily activity)? No (0p); Yes (2p). Physical activity (PA) in this survey was estimated using questions developed by the Swedish National Board of Health and Welfare (TNBHW) to estimate time spent physically active [16]: Time spending non-strenuous PA (e.g., walking, cycling, or gardening), or undertaking strenuous PA (e.g., jogging, swimming, basketball, or football) was estimated by the participants in minutes. Time conducting strenuous PA was multiplied by two and then summed with time spent doing non-strenuous PA [16]. Total minutes per week were then dichotomized into more, or less than PA 30 minutes per day.

How often do you eat vegetables, fruit or berries? Every day (0p), Not every day (1p).

Have you ever taken medication for high blood pressure on regular basis? No (0p); Yes (2p). Medication for high blood pressure included participants with medication with beta blockers,

calcium channel blockers, angiotensin-converting-enzyme inhibitors, angiotensin II receptor antagonists, diuretics.

Have you ever been found to have high blood glucose (e.g., in a health examination, during an illness or during pregnancy. No (0p); Yes (5p).

Have any of the members of your immediate family or other relatives been diagnosed with diabetes (type 1 or type 2)? No (0p); Yes: grandparent, aunt, uncle and/or cousin (3p); Yes: parent, brother, sister or own child (5p).

Statistical analysis

Analyses were performed using STATA IC/12.1. Least squares means were derived after age and sex adjustment using linear regression, whereas differences in proportions were adjusted for age and sex using logistic regression. Associations with T2D diabetes were estimated using multivariate logistic regression expressed as odds ratios (ORs) with 95% confidence intervals (95% CIs). Odds ratios (OR) were standardized (SD OR) per 1 SD unit variance for the independent variables. Standardizations were done in the strata of ethnicity and sex. All tests were two-sided and a p-value of <0.05 was considered statistically significant. Multicollinearity was tested for but was not considered an issue since all variance inflation factors (VIP) in the multivariate regression model had values <3.9.

Results

Basic characteristics of the study population, Table 1

In total, 1398 residents born in Iraq and 757 residents born in Sweden participated in this study. Although Iraqis were younger, twice as many were diagnosed with diabetes (new and previously diagnosed cases) (11.6 vs. 5.8%, $p<0.001$) and diabetes onset occurred on average six years earlier compared to Swedes. According to the prevalence of FINDRISC variables, Iraqis were worse off in almost all aspects with higher prevalence of abdominal obesity, overweight and obesity, family history of diabetes and physical inactivity.

Odds of diabetes and diabetes risk estimation, based on FINDRSIC scores

We studied the odds of T2D diabetes according to FINDRISC risk factors, but also included ethnicity as a risk factor. In this model, participants with larger waist circumference, family history of diabetes and/or hypertensive medication, independently of the influence of other risk factors had increased odds of T2D. In addition we also observed that the odds of T2D in participants born in Iraq were almost as high as in participants with a family history of diabetes. Within this survey ethnic background did not act as an effect modifier on the outcome of our data.

Participants without diabetes were categorized at “low”, “slightly elevated”, “moderate”, “high” and at “very high” risk for diabetes according to FINDRISC criteria, including participants with IGT or IGR in the very high risk group. Only 17.6% of Iraqi participants versus 33.4% of Swedish participants were at “low risk” for diabetes whereas a higher proportion of Iraqis were at “moderate” to “very high risk” of diabetes as compared to Swedes (Figure 2). Based on FINDRISC estimates of diabetes incidence the forthcoming decade [10], we assessed diabetes

incidence from the distribution of participants in each risk group (Figure 2). Our data revealed a higher proportion of the Iraqi than the Swedish born participants that were estimated to develop diabetes within the next ten years (16.2 vs. 12.3%, $p<0.001$, age and sex adjusted data).

Estimation of health related costs the coming decade in immigrants from Iraq to Sweden

Out of 125 000 Iraqi born individuals in Sweden in (2012), 73 000 were 30 to 75 years of age and within the same age groups as in this survey [17]. Based on our results, approximately 11.6% or 8 500 of the adult Iraqi population 30 to 75 years of age had T2D and of those that had not yet developed diabetes (64 500), we estimate that 16.2% or 10 500 will develop diabetes within the next decade. Thus 19 000 of the Iraqi population in Sweden are estimated to be diagnosed with diabetes in 2023 provided they are all still alive by then. Considering that a previous study from 2005 in Sweden have shown that for each individual that develop diabetes, the total annual cost (including healthcare costs, productivity loss, lost life-years and lost productivity years) is approximately EUR 3700 [8], we estimate that the total annual cost for diabetes in the Iraqi population will account for at least 7 mEUR. If the Iraqi population would have had a prevalence and incidence of diabetes within the level of the Swedish population 12 750 Iraqis are estimated to have diabetes in 10 years accounting for a total annual cost of 4.7 mEUR. This would equal a saved annual diabetes related cost for the Swedish society of 2.3 mEUR.

Representativeness of the study sample

The participants in this study were somewhat older compared to the eligible background population (Iraqis by 1.7 years, 95% CI 0.9-2.5, $p<0.001$; Swedes by 4.5 years, 95% CI 3.5-5.6,

$p<0.001$), but the prevalence of self-reported T2D in participants versus non-participants did not differ significantly (data not shown).

Discussion

Key findings

Our study suggests that Middle Eastern ethnicity should be considered an independent risk factor for T2D and in a clinical setting they should be tested for T2D on wide indications. Further our study suggests that the high proportion of immigrants from the Middle East that have or are estimated to soon develop T2D will generate substantial diabetes related costs for healthcare, productivity loss, lost life-years, lost productivity years not accounting for the effect on quality of life. There is an urge for culturally adopted intensive preventive actions in a clinical but also societal level targeting this high risk group, representing a large proportion of the Swedish population.

Population at risk for diabetes

To the best of our knowledge this is the first study to report estimates of diabetes incidence rates in immigrants from the Middle East that represent a high risk group of diabetes [18]. The high prevalence of T2D among the relatively young ethnic Iraqis in our study (11.6%) is higher than figures reported from Iraq in 2010 (7.8%) [19] which is in consistency with other studies reporting that migration per se increases the risk of developing T2D [5]. Our study also shows that the prevalence of T2D in ethnic Swedes has doubled since 1987 (from 3.3 to 5.8%) [20], which is also in consistency with recent reports of an increasing prevalence of diabetes globally that in Sweden is estimated to reach 8% in 2030 [19]. We consider Iraqi ethnicity, in the perspective of T2D prevalence, to be representative of Middle Eastern populations, as previous studies have reported similar prevalences of T2D in immigrants from the Middle East to

Northern Europe with risk estimates compared to natives ranging from OR=1.7 to 5.5 depending on setting and age-group studied [18]. This is consistent with our results (OR=2.5, 95% CI 1.6 to 3.9).

The estimated incidence rate of T2D in immigrants from Iraq in this survey is higher than in Swedes, but the actual incidence rate may be higher still. The early diabetes onset and worse metabolic control, as indicated by the high prevalence of Iraqi participants with overweight, abdominal obesity, family history of diabetes and physical inactivity, may result in a higher future risk of diabetic complications and early death. This supposition is supported by previous studies reporting that patients with early T2D onset progress to diabetic complication at a faster pace and have a shorter life expectancy than their older counterparts [21] and is also consistent with studies of patients with diabetes showing worse metabolic control in Middle Eastern immigrants to Sweden compared with non-immigrants [22]. Further, others have reported a high prevalence of micro- and macro vascular complications already in the pre-diabetic stages in Arabic populations [23].

Another factor that may influence the incidence rate is that recent studies have reported that immigrants from non-westernized countries to Sweden receive worse preventive health care and that they to a lower extent retrieve the preventive medication they are prescribed against chronic diseases such as diabetes and cardiovascular disease [24].

We also consider the actual costs to be considerably higher than the estimates used in this survey because the costs generated in the primary health care, where mostT2D patients are cared for, were not included in the analysis by Bolin et al. [8]. In addition, that survey presented estimates for 2005 and the costs have most probably increased since then.

Screening for diabetes

Our results altogether show that there is a substantial incitement for intensive preventive actions highlights a target population for intervention and screening in this high risk group, representing a large proportion of the immigrant Swedish population. Active screening for T2D combined with subsequent lifestyle intervention is cost-effective compared to the "wait and see" approach [25] that currently prevails in the Swedish society and health care of today. FINDRISC scores can be easily applied in a clinical setting for identification of individuals at high risk for diabetes. However, our data implies that Middle Eastern ethnicity per se is a risk factor for diabetes that is independent of overweight, diabetes family history or lifestyle factors. The reason for this is unclear but may be a consequence of metabolic differences affecting glucose metabolism not captured in the FINDRISC model. Our study further suggests that FINDRISC underestimates diabetes risk in immigrants from the Middle East; hence when estimating diabetes risk ethnic background should be taken into consideration. Considering that half of those with diabetes are undiagnosed [26] our data suggests that in a clinical setting, patients with Middle Eastern ethnicity should be tested for diabetes on broader indications than for lower risk ethnic groups, such as ethnic Swedes.

Randomized controlled trials have demonstrated that T2D can be delayed by preventive lifestyle interventions and that changes in lifestyle can reduce the risk of developing T2D substantially [27]. However, as proposed previously the use of risk scores in high risk populations to target public health interventions are sparse [9] and it is crucial that these interventions are culturally adopted since there are several obstacles and issues that need to be addressed in order to achieve successful lifestyle change in immigrants from the Middle East [28, 29].

Strengths and limitations

The major strengths of this study are that it is set in Sweden, where healthcare, education, and employment are equally accessible to immigrant and non-immigrant populations. Thus, confounding and bias attributable to these factors are likely to be less than in other study settings. Our study is also population-based and represents a large fraction of the Iraqi population within the studied region. The study is also distinct from other studies of this topic in that it includes detailed metabolic phenotyping and assessments of lifestyle exposures.

The age distribution in Iraqi and Swedish participants differed in the present study. However, because the Iraqi participants were younger than the Swedish participants, and older age is a risk factor for diabetes, it is unlikely that this age difference positively confounded the associations reported here.

The study is limited by the participation of more Iraqi men than women, which may reflect attitudes towards scientific research and other gender-specific sociocultural factors. Another limitation is the cross-sectional design making it difficult to draw conclusions regarding the order of causality in relation to T2D.

Conclusions

Our study suggests that Middle Eastern ethnicity in a clinical setting should be considered an independent risk factor for diabetes when estimating diabetes risk. The high proportion of ethnic Iraqis who have diabetes and are estimated to develop diabetes within the next decade will generate substantial diabetes-related costs owing to increased healthcare costs as well as productivity loss. An epidemic of this nature will also diminish the quality and duration of life in this population. Thus, culturally adapted intensive prevention strategies targeting this high risk

group which represents a large proportion of the Swedish population, may be warranted.

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Duality of interest

There are no conflicts of interests.

Contribution statement

L.B. wrote the manuscript, obtained, analyzed and interpreted the data. L.G. contributed to interpretation of the data and discussions. U.L. contributed to interpretation of the data and discussions. C-D.A, contributed to interpretation of the data, discussions and in writing the manuscript. P.W.F contributed to interpretation of the data, discussions and in writing the manuscript. All authors have revised/edited the article critically and have approved the final version of the manuscript.

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Figure 1. Flow diagram of the recruitment of the study population. PR, participation rate.

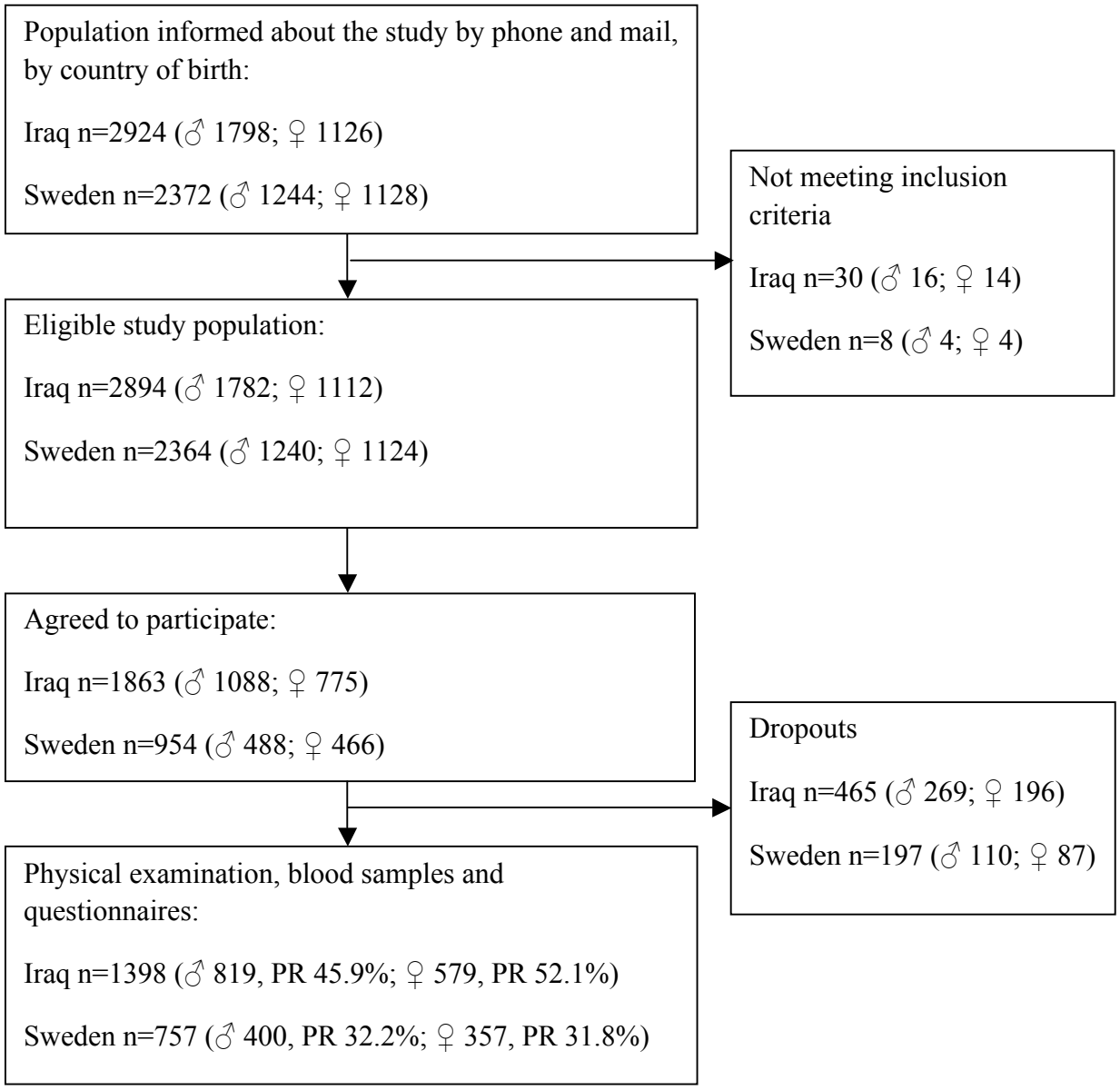

Figure 2. Distribution of Iraqi and Swedish participants without diabetes in relation to low, slightly elevated, moderate, high risk and very high risk of diabetes according to FINDRISC criteria. Participants with IGT or IGR were considered being at very high risk irrespective of other risk factors. Comparisons between Iraqi and Swedish participants were age and sex adjusted.

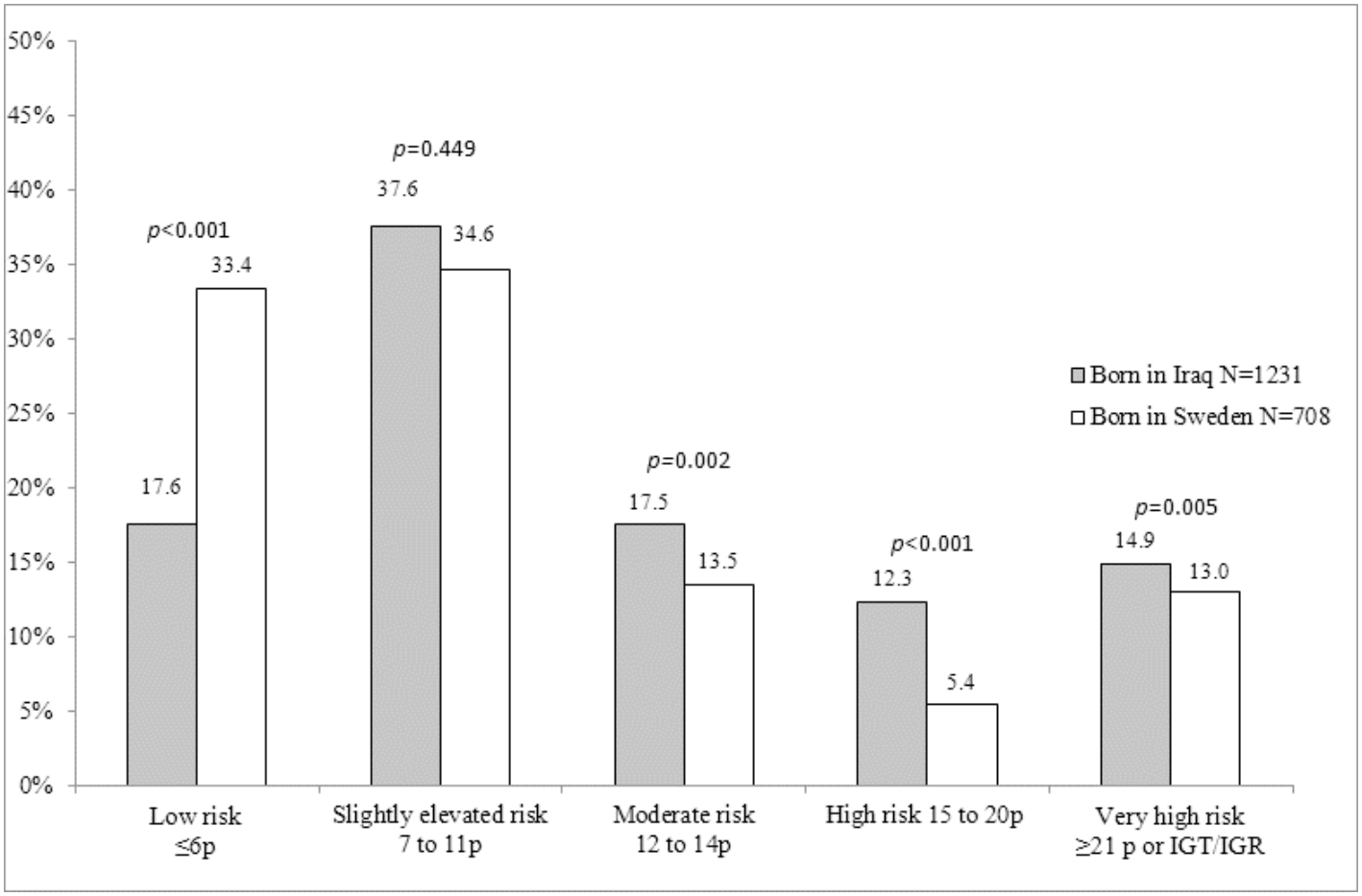

Table 1. Characteristics of residents of Malmö born in Iraq and Sweden according to FINDRISC risk factors for type 2 diabetes.

	Iraq *N*= 1398	Sweden *N*=757	*p*
Age, years	46.2 (9.6)	49.5 (11.2)	<0.001
Male sex, *n* (%)	819 (58.6)	378 (49.9)	0.010
Type 2 diabetes, new and previously diagnosed cases, *n* (%)	162 (11.6)	44 (5.8)	<0.001
Age at diabetes onset (years)	47.6 (9.9)	53.8 (13.0)	0.001
Age categories, years, *n* (%)			
<45	682 (48.8)	278 (36.7)	<0.001
45–54	466 (33.3)	225 (29.7)	0.087
55–64	193 (13.8)	166 (21.9)	<0.001
>64	57 (4.1)	88 (11.6)	<0.001
Body mass index, kg/m^2	29.3 (4.5)	27.3 (4.7)	<0.001
Body mass index, kg/m^2, *n* (%)			
<25.0	200 (14.3)	269 (35.5)	<0.001
25.0–29.9	674 (48.2)	314 (41.5)	0.005
≥30.0	524 (37.5)	174 (23.0)	<0.001
Waist circumference, men (cm)	99.3 (10.6)	93.1 (10.9)	0.002
Waist circumference, women (cm)	97.8 (11.7)	89.2 (14.1)	<0.001
Waist, cm (men; women), *n* (%)			
<94; <80	314 (22.5)	247 (32.6)	<0.001
94–102; 80–88	410 (29.3)	219 (28.9)	<0.001
>102; >88	674 (48.2)	291 (38.4)	<0.001
History of high glucose levels, *n* (%)	14 (1.0)	1 (0.1)	0.033
Physical activity <30 min/day, *n* (%)	1005 (71.9)	292 (38.6)	<0.001
Intake of vegetables, fruit or berries, less than every day, *n* (%)	715 (51.1)	373 (49.3)	0.803
Antihypertensive medication, *n* (%)	176 (12.6)	115 (15.2)	0.151
Family history of diabetes, *n* (%)			
No family history	659 (47.1)	489 (64.6)	<0.001
Second degree history	16 (1.1)	59 (7.8)	<0.001
First degree history	723 (51.7)	209 (27.6)	<0.001

Table 2. The odds of type 2 diabetes in participants born in Iraq or Sweden according to FINDRISC factors, associations expressed as odds ratios (OR) with 95% confidence intervals (CIs). Significant values are bolded.

	Univariate data			**Multivariate adjusted data N=1955**		
Risk factors in accordance with FINDRISC	**OR**	**95% CI**		**OR**	**95% CI**	
Born in Iraq	**2.12**	**1.50**	**2.99**	**2.52**	**1.64**	**3.87**
Age (years)	**1.08**	**1.06**	**1.09**	**1.11**	**1.04**	**1.08**
Male sex	**1.44**	**1.07**	**1.95**	0.86	0.57	1.30
BMI (kg/m^2)	**1.13**	**1.10**	**1.16**	0.99	0.93	1.06
Waist circumference (cm)	**1.07**	**1.06**	**1.08**	**1.06**	**1.03**	**1.09**
First degree family history of type 2 diabetes	**2.32**	**1.71**	**3.13**	**1.82**	**1.28**	**2.58**
Antihypertensive medication	**6.27**	**4.57**	**8.59**	**3.45**	**2.38**	**5.00**
Physical activity <30 min per day	1.15	0.86	1.55	1.03	0.72	1.47
Intake of fruit/vegetables less than daily	1.01	0.76	1.35	1.04	0.74	1.45

Data was analyzed using univariate and multivariate logistic regression. Neither history of high glucose levels, nor second degree family history of diabetes was included in the analysis because of few cases. Multicollinearity VIF<3.9.