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Evaluation of diabetes risk among Turkish nurses: The role of insulin resistance and life style on diabetes risk

Sultan Yurtsever[1], Birsen Yürügen[2], Tülin Saraç[3], Bennur Esen[1], Ahmet Engin Atay[1] and Dede Şit[1]
[1]Internal Medicine Department, Bağcilar Education and Research Hospital, Istanbul, Turkey; [2]Health Sciences School, Okan University, Tuzla, Istanbul, Turkey; [3]Pathology Department, Bağcilar Education and Research Hospital, Istanbul, Turkey

Aims: The aim of this study was to investigate diabetes risk in healthy young nurses in a Training and Research Hospital in Turkey.
Methods: The study was conducted in 338 nurses. Entire participants underwent laboratory examination including biochemical analysis and homoeostasis model assessment of insulin resistance. Risk of developing diabetes questionnaire (FINDRISK) was performed by interviewing with nurses. Pearson's simple linear regression analysis, Student's *t*-test, chi-square and Fisher's exact test were used for statistical analysis.
Results: Insulin resistance (IR) and impaired fasting glucose were observed in 41.1% ($n = 139$) and 21.6% ($n = 73$), respectively. Only 42.6% of participants had normal body mass index whereas 34.6% were overweight and 22.8% were obese. The percentage of nurses under the age of 45 years was 83.4%, of this population, only 17.8% of them had a lower diabetes risk.
Conclusions: Individuals with low diabetes risk may exhibit IR; however, IR is more frequent in individuals with high diabetes risk. Preventive measures and public awareness about these measures play a crucial role against diabetes risk.

Key words: Diabetes risk, HOMA-IR, insulin resistance, nurse

Introduction

Type 2 diabetes mellitus (DM) is the most frequent metabolic disorder of adults with increasing frequency due to augmented life expectancy, increased world population and changed life style.[1–4] According to the results of Turkish Diabetes Epidemiology Study and National Health and Nutrition Examination Survey-3, 30–50% of individuals that have an increased risk of DM or asymptomatic individuals with diabetes are unaware of their situation.[5]

Genetical and environmental factors implicate the pathogenesis of diabetes. Obesity, sedentary life style, carbohydrate-rich diet and consequently insulin resistance (IR) are well-defined risk factors in the development of DM among healthy young adults. IR is defined as biological unresponsiveness to endogenous or exogenous insulin. Genetical factors, foetal malnutrition, physical inactivity, obesity and advanced age are related to IR. The frequency of IR in healthy population, in individuals with impaired glucose tolerance (IGT) and in patients with Type 2 DM is 25, 60 and 60–75%, respectively.[6–8] Hyperinsulinaemia is an advanced stage of IR and develops to maintain euglycaemia.[5,9]

Prospective studies revealed that IR exists 20 years before the onset of Type 2 DM and is considered as one of the most important predictor of Type 2 DM. The study was conducted in nurses to analyse awareness of health staff against diabetes risk. Our principal aim was to investigate diabetes risk in young nurses.

Material and methods

Between October 2011 and June 2012, 418 nurses who work in Bagcilar Education and Research Hospital were enrolled into the study. Seventy nurses with diabetes, a history of gestational diabetes and a history of medication in last 3 months were excluded. Socio-demographic characteristics and health status of remaining 338 nurses were obtained by interviewing with them. Written informed consent was obtained from all the participants. Ethics Committee of Bagcilar Education and Research Hospital approved this study.

Diabetes development risk questionnaire (FINDRISK) was used to determine 10-year risk of diabetes with an accuracy rate of 85%.[10] Questionnaire was administered by interviewing with the participants. Homoeostasis model assessment of insulin resistance (HOMA-IR) was measured by globally validated formula: fasting insulin ($\mu U/ml$) $\times$ fasting glucose ($mmol/l$) $\times 0.0555/22.5$. HOMA-IR < 2.5 was considered as a normal and ≥ 2.5 indicates IR. Impaired fasting glucose (IFG) was defined as glucose level between 100 and 126 mg/dl.

Blood samples were obtained after 12-hour fasting period. Serum levels of total cholesterol, triglycerides, High density lipoprotein (HDL) cholesterol and low density lipoprotein (LDL) cholesterol were determined using an Aeroset autoanalyzer (Abbott Laboratories, Inc., Abbott Park, IL, USA). Plasma glucose levels

Address for correspondence: Sultan Yurtsever, Internal Medicine Department, Bağcilar Education and Research Hospital, Istanbul, Turkey.
Email: sultan.yurtsever@hotmail.com

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Table 1 Insulin resistance (HOMA-IR).

HOMA-IR (insulin resistance)	*n* (%)
HOMA-IR positive	139 (41.1)
HOMA-IR negative	199 (58.9)
Total	338 (100.0)

were measured using the glucose oxidase method. Plasma insulin concentrations were analysed by the Beckman Coulter chemiluminescent immunoassay (Beckman Instruments, Brea, CA, USA). Above 64 years of age have the highest score in FINDRISK questionnaire; however, the oldest nurse in this study was 54 years old, so participants were divided into two groups: < 45 years of age and ≥ 45 years of age.

Statistical analysis

Statistical calculations were performed using the SPSS for Windows computer program (release 15.0; SPSS, Inc., Chicago, IL, USA). All data were expressed as the mean ± standard deviation. Comparison of variables with a normal distribution between the study groups was analysed using Student's *t*-test. Correlations were determined by Pearson's simple linear regression analysis, chi-square and Fisher's exact test. A *p*-value of < 0.05 was taken to be statistically significant.

Findings

Two-hundred and seventy-two individuals (80.5%) were female and 66 (19.5%) were male. Seventy-seven of participants (22.8%) were graduates of health school, 49 (14.5%) were graduates of prelicence school, 187 (55.3%) were graduates of licence school, and 25 (7.4%) were graduates of high licence school.

IR was observed in 41.1% ($n = 139$) of non-diabetic nurses (Table 1).

One-hundred and thirty-nine nurses (41.1%) had IR and 73 nurses (21.6%) had IGT. Sixty-nine of 73 nurses (94.5%) with IGT had IR (Table 2). IR was observed in 70.5% of nurses who had diabetes in their first- or second-degree relatives.

According to FINDRISK questionnaire, body mass index (BMI) was $< 25\ kg/m^2$ in 42.6%, 25–30 kg/m^2 in 34.6% and $> 30\ kg/m^2$ in 22.8%. Ninety-one (26.9%) nurses had waist circumference (< 94 cm for men and < 80 cm for women), 172 nurses (50.9%) had waist circumference (94–102 cm for men and 80–88 cm for women), and 75 nurses (22.2%) had waist circumference (> 102 cm for men and > 88 cm for women). Almost none of the nurses (90.5%) had a habit of regular physical activity. Low diabetes risk was observed in 40.7% of nurses with regular physical activity; however, it was 15.7% for nurses with no regular physical activity. The percentage of participants with fresh fruit–vegetable eating habit was 50.3 ($n = 170$). Three-hundred and seven (90.8%) participants were normotensive and did not receive antihypertensive therapy. One-third (30.5%) of nurses had a history of increased or slightly increased glucose level. Nurses without first- or second-degree diabetic relatives constitute 13% of participants. On the other hand, the percentages of nurses with first and second-degree relatives with diabetes were 63.3 and 23.7%, respectively. Ninety per cent of nurses without first or second-degree relatives with diabetes had low diabetes risk. Diabetes risk of nurses with diabetic first or second-degree relatives was as follows: low (1.9%), mild (11.9%), moderate (20.5%), high (56.2%) and very high (9.5%).

Table 3 Diabetes risk levels of participants.

Diabetes risk	*n* (%)
Low	58 (17.8)
Mild	55 (16.9)
Moderate	62 (19.0)
High	130 (39.9)
Very high	21 (6.4)
Total	338 (100.0)

When the participants' findings were evaluated according to their diabetes risk levels, it was observed that 17.8% has a low-risk level ($n = 58$), 16.9% has a mild-risk level ($n = 55$), 19% has a moderate-risk level ($n = 62$), 39.9% of them has a high-risk level ($n = 21$) and 6.4% has a very high-risk level ($n = 21$) (Table 3).

There was a significant association between IFT and diabetes risk ($x^2 = 22\ 604$; $p < 0.05$). Low and mild risks were 11.6% ($n = 8$) and 10.1% ($n = 7$), respectively, in nurses with IFT (Table 4).

A significant association was observed between IR and diabetes risk ($x^2 = 32\ 732$; $p < 0.001$). High diabetes risk was observed in 53.4% ($n = 71$) of nurses with IR (Table 5).

Table 2 Association of IFG and HOMA-IR.

Comparison of IFG and HOMA-IR		HOMA-IR positive	HOMA-IR negative	
		n (%)	*n* (%)	*p*
IFG	Positive (+)	195 (73.6)	4 (5.5)	$x^2 = 109\ 643$; $p < 0.001$
	Negative (–)	70 (26.4)	69 (94.5)	

Table 4 Relation of IFT and diabetes risk.

		IFT (+)	IFT (–)	
		n (%)	*n* (%)	*p*
Diabetes risk	Low	50 (19.5)	8 (11.6)	$x^2 = 22\ 604$; $p < 0.001$
	Mild	48 (18.7)	7 (10.1)	
	Moderate	57 (22.2)	5 (7.2)	
	High	89 (34.6)	41 (59.4)	
	Very high	13 (5.1)	8 (11.6)	

Table 5 shows age-related risk factors and IR of participants. The frequencies of IR, IFG and low diabetes risk among nurses > 45 years of age were 66.1, 41.1 and 5.7%, respectively (Table 6).

Discussion

Environmental and genetical factors that play a crucial role in the development of IR are evident in the vast majority of patients with DM, IFG, and IGT.[5,9,11]

In 2001, Kern *et al.*[12] showed that there is a strong association between BMI and IR, and 11-fold increased risk was observed if BMI increases from 20 to 30 kg/m^2. Koyuer *et al.*[13] demonstrated a significant increase of IR in obese individuals. HOMA levels, a predictor of IR, also increase as a result of enhanced BMI. In this present study, IR and IFG were observed in 41.1 and 21.6% of participants, respectively. Individuals with normal BMI constitute only 42.6% of participants.

IFG and IGT are considered as early metabolic changes in the course of DM. Previously it was shown that 10-year risk of diabetes was 15% in patients with isolated IFG.[14,15] We observed a significant association between IFG and IR ($x^2 = 109\,643$; $p < 0.05$). IR was shown in 94.5% of nurses with IFG. Our results suggest an idea that as hyperglycaemia enhances, the severity of IR increases.

Icli *et al.*[16] concluded that measurement of IR can be used to identify patient at high risk of diabetes. There was a significant association between IR and diabetes risk in our study ($x^2 = 32\,732$; $p < 0.05$). High and very high diabetes risks were observed in 30.6 and 3.1%, respectively, of nurses without IR, whereas it was 53.4 and 11.3%, respectively, for nurses with IR. This result reflects higher diabetes risk in individuals with IR.

The role of genetical background was established by previous report.[5] Similarly, we observed an increased risk of DM in 30–40% of individuals with a family history of DM in first-degree relatives. Similarly, Uludag *et al.* stated that individuals with a family history of DM in their first-degree relatives have significantly higher glucose levels when compared to individuals without DM in first-degree relatives.[17] The frequency of IR was significantly higher in nurses with a family history of DM in first or second-degree relatives ($x^2 = 13\,507$; $p < 0.05$). IR frequency of nurses without a family history of DM was 29.5%; however, it was 48.6 and 27.5% for individuals with a family history of DM in first and second-degree relatives, respectively.

Table 5 Association of HOMA-IR and diabetes risk.

		IR (+)	IR (−)	
		n (%)	*n* (%)	*p*
Diabetes risk	Low	41 (21.2)	17 (12.8)	$x^2 = 32\,732$; $p < 0.001$
	Mild	41 (21.2)	14 (10.5)	
	Moderate	46 (23.8)	16 (12.0)	
	High	59 (30.6)	71 (53.4)	
	Very high	6 (3.1)	15 (11.3)	
Total		193 (100.0)	133 (100.0)	

Table 6 Distribution of diabetes risk factors according to age.

		< 45 years of age ($n = 282$)	> 45 years of age ($n = 56$)	
		n (%)	*n* (%)	*p*
Hypertension	(−)	261 (92.6)	46 (82.1)	$\chi^2 = 6078$; $p = 0.014$
	(+)	21 (7.4)	10 (17.9)	
IR	(−)	180 (63.8)	19 (33.9)	$\chi^2 = 17\,253$; $p < 0.001$
	(+)	102 (36.2)	37 (66.1)	
Fresh fruit–vegetable eating habit	Not every day	146 (51.8)	24 (42.9)	$\chi^2 = 1486$; $p = 0.223$
	Every day	136 (48.2)	32 (57.1)	
Regular physical exercise	(−)	254 (90.1)	52 (92.9)	$\chi^2 = 0423$; $p = 0.515$
	(+)	28 (9.9)	4 (7.1)	
IFG	(−)	232 (82.3)	33 (58.9)	$\chi^2 = 15\,032$; $p < 0.001$
	(+)	50 (17.7)	23 (41.1)	
BMI	< 25 kg/m^2	131 (46.5)	13 (23.2)	$\chi^2 = 20\,123$; $p < 0.001$
	25–30 kg/m^2	99 (35.1)	18 (32.1)	
	> 30 kg/m^2	52 (18.4)	25 (44.6)	
Waist circumference	0 point	87 (30.9)	4 (7.1)	$\chi^2 = 41\,320$; $p < 0.001$
	3 points	150 (53.2)	22 (39.3)	
	4 points	45 (16.0)	30 (53.6)	
Diabetes risk	Low	55 (20.1)	3 (5.7)	$\chi^2 = 51\,422$; $p < 0.001$
	Mild	52 (19.0)	3 (5.7)	
	Moderate	60 (22.0)	2 (3.8)	
	High	97 (35.5)	33 (62.3)	
	Very high	9 (3.3)	12 (22.6)	
Glucose	< 100	238 (84.7)	37 (66.1)	$\chi^2 = 11\,349$; $p = 0.003$
	100–125	42 (14.9)	18 (32.1)	
	> 126	1 (0.4)	1 (1.8)	
Family history of DM	(−)	211 (74.8)	24 (42.9)	$\chi^2 = 22\,533$; $p < 0.001$
	(+)	71 (25.2)	32 (57.1)	

Reversible risk factors of diabetes are obesity, physical inactivity, smoking, alcohol intake, low intake of fibre and high intake of saturated lipids. Irreversible risk factors are ethnicity, age, gender, family history of hypertension and dyslipidaemia.[5]

Although 82.2% of nurses was < 45 years of age, only 17.8% have lower diabetes risk. This result suggests that the vast majority of participants will be diabetic in next 10-year period. Age is a significant risk factor of diabetes. Kahn *et al.*[18] determined a significantly higher incidence of IR above the age of 45 which was similar to our results. In the present study, frequency of IR below and above 45 years of age was 36.2 and 66%, respectively ($x^2 = 17\,253$; $p < 0.05$).[18] Low risk of diabetes was observed in 20.1% of nurses < 45 years of age, whereas it was 3% for nurses > 45 years of age.

According to a study by Aydin *et al.*,[19] BMI was the single determinant of DM. They concluded that 1 kg/m^2 increase in BMI may lead to 38% increase in diabetes risk which may be reversed by life style modifications. BMI > 25 kg/m^2 was observed in 57.4% of our participants. A statistically significant association was determined between age and BMI ($x^2 = 20\,123$; $p < 0.05$). The ratio of overweight or obese nurses below 45 years of age was 53.5%; however, it was 76.8% of nurses above 45 years of age.

In our study, 9.5% of nurses were making regular physical activity. Physical activity may reduce the risk of diabetes in individuals with high diabetes risk. Minimum 5 days/week and 30 minutes/day of mild or moderate aerobic activity is warranted to improve health care and to reduce risk of chronic diseases.[20]

Regulation of nutrition has vital importance on the development of DM. Excessive weight gain is the initial step on the way from IFG and IGT to Type 2 DM.[21] Life style modifications to improve nutritional habits play a crucial role in the prevention of DM. Aydin *et al.*[19] established that low lipid and high fibre intake prevents or delays development of DM in pre-diabetic patients. In our study, approximately half of nurses (50.3%) had regular fresh fruit and vegetable diet.

The role of diabetes nurses has an importance on the management of patients with diabetes which will improve patient's consistency to treatment as well as his accommodation to life style modifications. Dietary restrictions and daily exercises have significant impact on the regulation of the blood glucose level.[22] Diabetes nurses also act as a role model for patients and their family members. As a health care promoter, diabetes nurses should also motivate patient's family members to participate to follow-up period. Especially at the first years of chronic disorders like DM, patient's accommodation is achieved by close communication with physician and diabetes nurses.

Recently, younger population is under higher risk of metabolic disorders than ever because of eating habits and sedentary life style.[23] Because of technical innovations, individuals are less likely to make physical activity. On the other hand, fast food culture is globally growing life style which increases the frequency of obesity. Accordingly, younger individuals are more prone to diabetes, obesity and hyperlipidaema.[24,25] Public measures against obesity and DM play a crucial role to prevent the development of DM as well micro- and macro-vascular complications.[12,26,27] Before the development of diabetic nephropathy, retinopathy and neuropathy, life style modifications should be instituted intensively.[13,28]

The present study has some limitations. First, the number of patients was relatively low. Second limitation was lack of control group that may overwhelm the underestimation of true relationship. Third, our study population was composed of Turkish nurses that inhibit to generalize our results to other populations.

In conclusion, our results showed that high diabetes risk and IR were associated with obesity, absence of regular physical activity and fresh fruit–vegetable diet as well as genetical background. Further large-scaled studies are required to increase public and health staff awareness against Type 2 DM and reach more precise conclusion.

Disclaimer statements

Contributors SY, BY and TS planned and conducted the study. SY, BE, AEA and DS participated in the interpretation of the results. SY, BY and BE wrote the manuscript. SY, BE and AEA edited and submitted the manuscript.

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Conflicts of interest The authors declare that there are no conflicts of interest.

Ethics approval Ethics committee of Bagcilar Education and Research Hospital approved the study.

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