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A study of the application of EZSCAN in pilots and in the general population

Badanie zastosowania techniki EZSCAN wśród pilotów i w populacji ogólnej

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Abstract

Introduction: This study aims to evaluate EZSCAN detection in pilots and in the general population, and to determine the significance of EZSCAN detection in the identification of pilots' health.

Material and methods: A total of 87 cases of non-diabetic Air Force pilots (pilot group) and 49 cases from the general population without diabetes were collected. These two groups of subjects underwent EZSCAN detection, as well as the detection of blood glucose, lipid, and uric acid levels.

Results: Subjects in the pilot group had the highest detection rate of no risk and the lowest detection rate of high risk, while the general population had the highest detection rate of high risk, followed by low risk. The difference in diabetic risk between these two groups was statistically significant ($P < 0.01$). Various indicators were compared according to different risk levels. In the no risk group, age, BMI, and the triglyceride of pilots were lower than in the general population, and the difference was statistically significant ($P < 0.05$). In high risk group, BMI and blood uric acid of pilots were lower than in the general population, and the difference was statistically significant ($P < 0.05$).

Conclusions: BMI and blood uric acid are positively correlated with diabetic risk. The EZSCAN detection system can be used for assessment of pilots' diabetic risk and has certain significance in pilots' health identification. **(Endokrynol Pol 2018; 69 (3): 259–263)**

Key words: *EZSCAN; pilots; health check-up populations; diabetes risk assessment*

Streszczenie

Wstęp: Badanie miało na celu ocenę wykrywalności ryzyka wystąpienia cukrzycy techniką EZSCAN wśród pilotów i w populacji ogólnej oraz określenie znaczenia wykrywalności techniką EZSCAN w identyfikowaniu zdrowia pilotów.

Materiał i metody: W badaniu wzięło udział 87 niechorujących na cukrzycę pilotów sił powietrznych *Air Force* (grupa pilotażowa) oraz 49 osób nieobciążonych cukrzycą z populacji ogólnej. W obu grupach przeprowadzono detekcję techniką EZSCAN, jak również zbadano stężenie glukozy we krwi, lipidów oraz kwasu moczowego.

Wyniki: U pacjentów z grupy pilotażowej wykazano najwyższy wskaźnik wykrywalności nieobciążenia ryzykiem i najniższy wskaźnik wykrywalności obciążenia wysokim ryzykiem, podczas gdy u pacjentów z populacji ogólnej wykazano najwyższy wskaźnik wykrywalności obciążenia wysokim ryzykiem, po którym następowało niskie ryzyko. Różnica dotycząca ryzyka cukrzycy między obydwoma grupami była istotna statystycznie ($p < 0,01$). Porównano różne wskaźniki zgodnie z różnymi poziomami ryzyka. W grupie nieobciążonej ryzykiem, wiek, wskaźnik BMI i stężenie trójglicerydów pilotów były niższe niż w populacji ogólnej, a różnica była statystycznie istotna ($p < 0,05$). W grupie obciążonej wysokim ryzykiem, wskaźnik BMI i stężenie kwasu moczowego we krwi pilotów były niższe niż w populacji ogólnej, a różnica była statystycznie istotna ($p < 0,05$).

Wnioski: Wskaźnik BMI i stężenie kwasu moczowego we krwi są dodatnio skorelowane z ryzykiem wystąpienia cukrzycy. Metoda EZSCAN może być stosowana do oceny ryzyka wystąpienia cukrzycy u pilotów i ma pewne znaczenie w określaniu stanu zdrowia pilotów. **(Endokrynol Pol 2018; 69 (3): 259–263)**

Słowa kluczowe: *EZSCAN, piloci, populacja kontrolna, ocena ryzyka zagrożenia cukrzycą*

Introduction

The prevalence of diabetes continuously increases. According to the Chinese chronic disease surveillance and the research of the special investigation on diabetes project, there may be as many as 113.9 million adult diabetic patients, and 493.4 million pre-diabetic people in China [1]. Diabetes mellitus has become a major public health problem in China. Effective intervention in the pre-stage of diabetes can significantly reduce its conversion to diabetes. Therefore, detecting the high-risk population and pre-stage population of diabetes in time and conducting effective management are keys to prevent the occurrence of diabetes [2]. EZSCAN (sweat gland ionic diabetic risk assessment system) is a new method of early diabetic risk assessment. It evaluates the risk of glucose metabolism by detecting sweat gland function via the reverse ion method. The test result is stable, and repeatability is high. Therefore, it has good prospective application in the screening of individuals

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with high risk of diabetes and diabetic patients [3, 4]. Flight personnel are a special group, and studies of the risk of diabetes in pilots are rare. In this study, the EZSCAN system was used to explore the identification of diabetic risk and health in the general population and in the pilot population.

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Material and methods

Material

Data on people who underwent health examinations in the Air Force General Hospital Health Examination Centre between January and July in 2014 were collected. These subjects were divided into two groups: the pilot group (87 cases, of whom 82 were male and five were female) and the general non-diabetic group (general group; 49 cases, 45 cases were male and four were female). Exclusion criteria: subjects with diabetes, or with severe liver and kidney dysfunction, pregnant or lactating women, or patients with other major diseases; patients with cardiac pacemakers or implanted defibrillators; patients who had defects in some parts of the body, which could not be detected by EZSCAN; subjects allergic to nickel or other electrodes.

Methods

Physical examination

Body height and weight of the subjects were measured using the Beijing Haiboerda height and weight measurement instrument.

Laboratory examination

Venous blood was collected from all subjects after fasting for at least 10 hours, the samples were sent to the hospital inspection centre, blood glucose and blood uric acid were detected using a Hitachi 7600 automatic biochemical analyser, and the blood lipids were simultaneously detected including total cholesterol, triglyceride, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol.

EZSCAN diabetic risk assessment system

All subjects were detected by the EZSCAN diabetes and complication risk detection system, which was produced by Impeto Medical (France). EZSCAN has two kinds of work mode. The common mode is used for non-diabetic patients, in order to detect whether there is a risk of diabetes. The results are expressed with the comprehensive percentage of risk. The reading range is 0–100%. A range within 0–25% indicates no risk, a range within 25–50% indicates low risk, and a range within 50–100% indicates high risk; thus, a higher ratio represents a higher risk of diabetes [5].

The subjects do not need to fast for the detection, and high-intensity exercises should be prohibited two hours before the examination. The operator should clean the electrode plate, select the correct detection mode, and accurately input the subject's information according to the requirements. The electrodes should be placed at the areas of the subjects with an abundant sweat gland (two hands, two feet), and the subjects should stand quietly for 2–3 minutes. During the whole measurement process, the hands and feet of the subject should be located in the centre of the electrode plate, and the limbs should not be moved, to ensure the accuracy of the detection results. EZSCAN then calculates the electrical conductivity of the corresponding parts. The higher the value, the lower the risk of abnormal blood glucose. During the detection process, environmental and human disturbance factors should be avoided, in order to ensure the accuracy of the detection results.

Statistical methods SPSS 20.0 statistical software was used for data analysis. Continuous variables were expressed with $\overline{\chi} \pm$ s, and categorical variables were expressed with case numbers (%). The comparison of continuous variables between these two groups was analysed using the Mann-Whitney method. The rates between these groups were compared by chi-square test. A P-value < 0.05 was considered statistically significant.

Results

Analysis of EZSCAN in the detection of diabetic risk

Among the 87 subjects in the pilot group, 29 subjects were at low risk and eight subjects were high risk. Among the 49 subjects in the general group, 16 subjects were at low risk and 18 subjects were at high risk. Subjects in the pilot group had the highest detection rate of no risk and the lowest detection rate of high risk, while subjects in the general group had the highest detection rate of high risk, followed by low risk. The difference in diabetic risk between these two groups was statistically significant ($X^2 = 9.063$, $P < 0.01$; Table I).

Table I. *EZSCAN results comparison between pilots and general population [Number (%)]*

Tabela I. *Porównanie wyników badania za pomocą techniki ESZCAN wśród pilotów i populacji ogólnej (%)*

Groups	Pilots	General population	χ^2 value	P value
Non-risk	50	15		
Risk	37	34	9.063	0.003

Table II. *Basic data of pilots and general population [$\overline{\chi} \pm s$]*
Tabela II. *Dane dotyczące pilotów i populacji ogólnej [$\overline{\chi} \pm s$]*

	General population			Pilots			P value		
	Normal	Low-risk	High-risk	Normal	Low-risk	High-risk	Normal	Low-risk	High-risk
Number	15	16	18	50	29	8			
Age	44.27 ± 5.56	50.75 ± 7.90	56.17 ± 11.56	37.16 ± 10.54	46.07 ± 8.47	49.50 ± 7.93	0.024	0.196	0.29
BMI	27.16 ± 3.05	25.41 ± 3.92	28.52 ± 2.84	25.00 ± 2.45	25.16 ± 3.19	25.26 ± 3.04	0.015	0.859	0.023

Table III. *Biochemical test results of pilots and general population [$\overline{\chi} \pm s$]*
Tabela III. *Wyniki testów biochemicznych wśród pilotów i populacji ogólnej [$\overline{\chi} \pm s$]*

	General population			Pilots			*P value*		
	Normal	Low-risk	High-risk	Normal	Low-risk	High-risk	Normal	Low-risk	High-risk
GLU	5.28 ± 0.71	5.28 ± 1.51	5.39 ± 0.85	5.10 ± 0.42	5.06 ± 0.38	5.41 ± 0.99	0.421	0.359	0.867
TC	4.95 ± 1.03	5.14 ± 1.32	4.78 ± 0.86	4.55 ± 0.77	4.83 ± 0.71	4.38 ± 0.72	0.207	0.361	0.243
TG	3.50 ± 3.08	3.56 ± 5.44	2.25 ± 1.25	1.31 ± 0.78	2.17 ± 1.69	1.84 ± 1.15	0	0.158	0.505
HDL	1.10 ± 0.21	1.28 ± 0.41	1.10 ± 0.24	1.25 ± 0.31	1.19 ± 0.25	1.08 ± 0.20	0.05	0.602	0.934
LDL	2.94 ± 0.89	2.90 ± 1.02	2.89 ± 0.69	2.73 ± 0.64	2.98 ± 0.69	2.60 ± 0.54	0.511	0.749	0.331
BUA	397.67 ± 73.96	398.94 ± 132.16	406.39 ± 71.74	355.47 ± 69.41	356.10 ± 87.58	354.88 ± 28.59	0.101	0.538	0.024

Different diabetic risk-related biochemical indicators in the two groups of populations

Test results of biochemical indicators at different diabetic risk levels for both the pilot and general groups are shown in Table II and III. Subjects in the pilot group had the highest detection rate of no risk and the lowest detection rate of high risk, while subjects in the general group had the highest detection rate of high risk, followed by low risk. The difference in diabetic risk between these two groups was statistically significant ($P < 0.01$). Different indicators were compared according to diabetic risk levels. In the no-risk group, age, BMI, and triglyceride levels of pilots were lower than in the general population, and the difference was statistically significant ($P < 0.05$). In the high-risk group, BMI and blood uric acid levels of pilots were lower than in the general population, and the difference was statistically significant ($P < 0.05$).

Discussion

In order to detect and treat diabetes at an early stage, the American Diabetes Association (ADA) proposed a large-scale diabetic screening programme in the general population. This would provide intervention on diabetic risk factors, in order to provide the early diagnosis and treatment of diabetes, reduce complications, and decrease medical costs, thereby improving the quality of life of patients [6]. ADA guidelines recommend that populations > 45 years of age or with BMI ≥ 25 should undergo glucose metabolism screening [7]. However, survey results revealed that the majority of these populations did not undergo the corresponding detection. The main reason was that the commonly used screening method (OGTT) was invasive and patient compliance was poor [8]. At present, there are a lot of limitations in traditional diabetic detection methods. Diabetes could not be completely and accurately diagnosed solely through detection of fasting blood glucose, glycosylated haemoglobin, and blood glucose at two hours after a meal. By reverse iontophoresis counting, EZSCAN detection can evaluate whether the sweat gland function is abnormal through measuring sweat chloride concentrations and calculating the conductance of the corresponding parts. Fibrotic lesions appear in sympathetic nerves (which dominate the sweat glands) in the early stage of diabetes and in the impaired glucose tolerance period. This causes the dysfunction of sweat glands, resulting in decreased sweat chloride ionic concentration and electrical conductivity. This abnormality can be detected in diabetes even during the impaired glucose tolerance period [5, 9]. Mayaudon et al. [9] performed EZSCAN and blood glucose detection on 133 diabetic patients and 41 healthy subjects and found that the conductivity of the diabetic group was significantly lower than in the healthy control group.

Furthermore, when the EZSCAN cut-off point was 50%, the diagnostic sensitivity and specificity of diabetes was 75% and 100%, respectively. Ramachandran et al. [5] performed EZSCAN and glucose test on 212 subjects and found that when the EZSCAN cut-off point was 50%, the diagnostic sensitivity and specificity of diabetes were 75% and 54%, respectively, and sensitivity was higher than in fasting plasma glucose (FPG, 29%). Sheng et al. [10] performed EZSCAN tests on 195 subjects. They also found that conductivity in the diabetic group was significantly lower than in the non-diabetic group. When the EZSCAN cutoff point was 40%, the diagnostic sensitivity and specificity of diabetes were 85% and 64%, respectively, and sensitivity was much higher than in FPG (44%) and HbA1c (56%). These results suggest that EZSCAN, as a new diabetic screening tool, is safe, noninvasive, and simple. Furthermore, test results are not easily hampered by the detection time, place, and gender of the subject. Moreover, it may have higher sensitivity and specificity, compared with traditional FPG and HbA1c detection [11, 12]. All these factors indicate that EZSCAN is an appropriate method that can be carried out for the early screening of diabetes in large-scale populations.

In this study we found that the risk of diabetes in the pilot population was lower than in the general population. This is because pilots are a special group of people. They have undergone strict screening and evaluations, and their physical qualities are superior to those of the general population. Furthermore, they maintain a regular diet, perform regular exercise, and practice good living habits. In a disease spectrum study performed by Liu Hongjin et al. [13] on fighter pilots who were unqualified to fly, they found that there was an upward trend of hypertension and diabetes proportions in all the diseases that caused grounded. Wang Binru et al. [14] found that diabetes was one of the 10 diseases that caused aircrews to be grounded and affected an aviator's service span. Through analysis of the disease spectrum of pilots' annual physical examinations, Menke et al. [15] found that there was a high incidence of hyperlipidaemia, fatty liver, hyperuricaemia, and other endocrine, nutritional, and metabolism-related diseases. Therefore, it is necessary to monitor disease spectrum changes, and prevent and detect diabetes in the early stage. The results of this study revealed that blood uric acid levels in subjects in the high-risk group were higher than that in the low-risk group and normal group, which was consistent with previous research results [10, 16]. From the results of the study, we can observe that even in a high-risk population, the pilots' BMI and blood uric acid values were lower than in the general population.

The age of subjects in the high-risk diabetic groups in these two kinds of populations were both higher than in the normal and low-risk groups. With the increase of age, the prevalence rate of diabetes exhibits a sharp upward trend. Hence, the greater the age, the higher the probability of suffering from diabetes becomes. This may be related to the atrophy of internal organs that starts during middle age and the decline of a variety of functions, excessive nutrition caused by poor lifestyle, decreased body sensitivity to insulin, and other factors. The trend of the prevalence rate of diabetes in the pilot population is becoming younger, which is related to the gradual reduction in physical activity and obesity. In this study, we found that the BMI index in the high-risk diabetes group for pilots and the general population was greater than in normal and low-risk groups. As BMI increased, the risk of abnormal glucose metabolism also increased. Furthermore, obesity is a very important risk factor for the occurrence and development of diabetes, which is consistent with the results of many related studies [17–20]. Therefore, controlling body weight has a positive effect on reducing the risk of abnormal glucose metabolism.

In China, the incidence rate of impaired glucose tolerance (IGT) is much higher than that of impaired fasting glucose (male: 11% vs. 3.2%; female: 10.9% vs. 2.2%) [21]. Therefore, it is very important to screen patients with IGT for the prevention and treatment of diabetes in China. Ramachandran et al. [5] performed EZSCAN and blood glucose examinations on 212 subjects and found that when the EZSCAN cut-off point was 50%, IGT detection sensitivity was 70%, which was significantly higher than in FPG (3%) when the cut-off was set at 6.1 mmol/L. Subsequently, Ramachandran [22] followed-up 69 subjects with normal glucose metabolism for eight months and found that 23% of these subjects developed into IGT or diabetes. Survival curve analysis indicated that the risk of IGT incidence in patients with high risk (risk > 65%) increased 6.19 times (OR: 6.19, 95% CI: 1.50–25.48) and the risk of IGT incidence in patients with medium risk (the risk was between 50% and 65%) increased by a factor of three (OR: 3.0, 95% CI: 0.98–9.19), compared to low-risk patients (EZSCAN risk percentage < 50%). In this study, it was also found that the sensitivity of EZSCAN in abnormal glucose tolerance detection was 77%, which was higher than for FPG (14%) and HbA1c (66%). All of the above results suggest that EZSCAN has higher sensitivity for the detection of IGT, compared with traditional methods of blood glucose detection, and that this may have some predictive value for the occurrence of abnormal glucose metabolism. The EZSCAN diabetes risk score was significantly and positively correlated with the risk of type-2 diabetes.

EZSCAN diabetes risk assessment system does not require fasting. It is noninvasive, can detect rapidly, is easy to perform, has high compliance, and is easy to popularise. Furthermore, it is especially suitable for diabetic risk screening when conducting physical examinations for a certain population and in carrying out health management activities in a population with diabetic risk. Although the diabetic risk in the pilot population was significantly lower than in the general population, in order to ensure the fighting capacity of the army, early screening should be performed on pilots. The detection of diabetic risk at an early stage would enable individuals to receive intervention at an early stage.

Competing interests

We declare that we do not have any commercial or associative interest that represent a conflict of interest in connection with the work submitted.

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