Screening for identifying individuals at risk of developing type 2 diabetes using the Canadian diabetes risk (CANRISK) questionnaire

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ORIGINAL ARTICLE

Screening for identifying individuals at risk of developing type 2 diabetes using the Canadian diabetes risk (CANRISK) questionnaire

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Abstract

Aim This study aimed to screen healthy individuals with the risk of developing type 2 diabetes.

Methods This study was a cross-sectional study with a simple random sampling technique. The instrument used was the CANRISK questionnaire.

Results Approximately 327 respondents participated in this study. The result of the study shows that 34.5% ($n = 113$) of participants had a low-risk factor, 40.7% ($n = 133$) had a medium risk factor, and approximately 24.8% ($n = 81$) of them had a high-risk factor for developing type 2 diabetes mellitus in the next ten years based on the CANRISK questionnaire assessment. There was a positive correlation between the total score of the CANRISK and age ($p = 0.000$; r = 0.511), BMI ($p = 0.000$; r = 0.657), and waist circumference ($p = 0.000$; r = 0.673). In a differential test analysis, there were significant differences between gender ($p = 0.000$), history of hypertension ($p = 0.000$), family history of diabetes mellitus ($p = 0.001$), and education ($p = 0.001$) in the risk category of the CANRISK.

Conclusion The higher the total score obtained based on the CANRISK questionnaire, the higher the risk for developing type 2 diabetes mellitus in the next ten years.

Keywords CANRISK · Diabetes mellitus · Prediabetes · Public health · Risk assessment · Screening

Introduction

According to the International Diabetes Federation (IDF) Diabetes Atlas, in 2019, 463 million people worldwide have been diagnosed with diabetes (Karuranga et al. 2019). This figure is projected to rise to 578 million by 2030 and 700 million people by 2045. It is estimated that of the 463 million people diagnosed with diabetes, there are 212.4 million people, or nearly half of them have not been reported, implying that the prevalence may be higher. Diabetes will progress into a dangerous complication if it is not treated and prevention efforts are not made. With approximately 10.3 million diabetics, Indonesia ranked sixth among the top ten countries in 2017, trailing China, India, the United States, Brazil, and Mexico. Meanwhile, Indonesia is expected to rank seventh in 2045, with an estimated 16.7 million diabetics. Diabetes mellitus affects 10,276,100 of Indonesia's 166,531,000 adults (aged 20–79 years), with a prevalence of 6.2%.

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The government has made various attempts to deal with diabetes mellitus, including implementing health promotion programs, including early identification of risk factors. The government also provides Posbindu PTM (Integrated Non-Communicable Diseases Development Post) as a PTM risk factor control program to increase public awareness of risk factors for both their families and the local community. It also advises the public to carry out routine tests, regular treatment, change their nutritional lifestyle, and be vigilant in their physical activity to be healthier (Indonesia's Minsitry of Health 2020).

The community pharmacist plays a key role in society by implementing preventive programs, specifically by screening and assisting patients in monitoring and controlling their disease progression (George and Zairina 2016). Community pharmacies are located in areas where people can seek advice on minor illnesses, symptoms that are often similar to early signs of diabetes mellitus and other issues. Pharmacies are also an excellent location to offer screening services for the detection of risk factors (Ayorinde et al. 2013). Community pharmacies are now available in rural and urban areas and most countries worldwide, making them more accessible. For example, in the United Kingdom, approximately 90% of the population visits community pharmacies at least once each year. The roles of pharmacists in the community include responding to patient requests, providing advice on symptoms therapy, and providing health promotion advice (Anderson 2000).

Screening is a set of tests intended to determine a person's risk factors for certain diseases as consideration for further examination (Strong et al. 2005). Screening is designed to save lives or enhance an individual's quality of life by early detection so that screening will minimize the risk of developing a condition or its complications (Braveman et al. 1994). Stroke, cardiovascular disease, hypertension, and other diseases can all occur as complications (Lastra et al. 2014). Diabetes screening is also required to minimize medical costs such as hospitalization, outpatient care, surgery, medications, and laboratory test costs (Naser et al. 2020). This screening approach was first introduced in Finland, as diagnostic tests for blood sugar and oral glucose were quite expensive. Screening using the Diabetes Risk Score is an easy way to detect diabetes mellitus (Buijsse et al. 2011).

"The Canadian Diabetes Risk Questionnaire" (CANRISK) is one of the screening tools that can be used. CANRISK is a questionnaire-based screening tool that has been validated in Canada to assess risk factors for type 2 diabetes using a variety of tests (Kaczorowski et al. 2009). CANRISK is an updated version of the FINDRISC questionnaire, where the questions on the CANRISK questionnaire are more diverse to represent diabetes risk factors better, and some new questions have been added (Štiglic et al. 2016).

According to a study conducted in India with 350 respondents, employees who work in an institution are at a high risk of contracting noncommunicable diseases. Employees have a sedentary lifestyle as a result of sitting for too long at work. The findings also revealed that employees' consumption of fruits and vegetables was insufficient. As a result, it is critical to strengthen early prevention by promoting a healthier lifestyle at work, including increased physical activity and fruit and vegetable consumption, as a preventive measure against noncommunicable diseases (Sandhu et al. 2016). Screening for risk factors with questionnaires and diagnostic tests is highly recommended because it can reduce mortality and is highly beneficial for people at high risk of developing diabetes mellitus (Pottie et al. 2012).

Based on the above background, the high success rate of screening to prevent diabetes mellitus in individuals evaluates disease risk as a critical part of the disease prevention process. Therefore, the objective of this study is to identify the likelihood of individuals developing diabetes mellitus in the next ten years.

Methods

The research was carried out at a public institution in Surabaya, Indonesia, from March to September 2019. A random number generator on a computer was used to select participants at random from the employer database. Participants were excluded if they had been diagnosed with diabetes and were taking anti-diabetic medication, as well as if they were pregnant. The Human Research Ethics Committee approved the study. Participants were first asked to complete a consent form, demographic information, and the CANRISK questionnaire. The participants' height and weight were then measured to calculate their BMI (BMI). BMI was calculated as weight in kilograms divided by height in meters squared. The waist circumference of each participant was also measured.

The demographic profiles of the participants were identified using descriptive analysis. Age, gender, weight and height, education, occupation, medication taken, family history of diabetes mellitus, daily activities, and smoking status were among the demographic data collected. Prior to analysis, the data's normality was assessed. The relationship between each risk factor in the CANRISK questionnaire was examined using a Spearman correlation. IBM SPSS version 22.0 was used to analyze all the data.

Results

There were 2131 employees in the database, and only 538 (25%) employees met the inclusion criteria. Of those who met the inclusion criteria, 327 (60%) agreed to participate in

the study. After gaining consent, the researcher informed the prospective respondents about the study's aim and objective. Respondents eligible to participate were asked to fill out the consent form as well as the demographic data sheet and questionnaire. The study has been approved by the Public Health Agency of Canada (Ref: HC2020–0259) to translate and adapt the CANRISK questionnaires to be used in this study.

Participants' mean age is 40 years ± 8.91, with most of the participants in the age group below 44 years (62.4%, $n = 204$). The education demographic showed that nearly 50 % of respondents ($n = 163$) graduated from university. The number of male respondents was larger than the number of females, accounting for 228 (69.7%) of the total population (Table 1). Based on the BMI value, most BMI categories were in the normal/underweight category, namely 48 (48.5%) for women and 106 (46.5%) for men (Table 2). The CANRISK's waist circumference of females was in the highest category >88 cm, approximately 44 (44.4%) and < 94 cm for men, accounting for 144 (63.2%) (Table 2).

In terms of physical activity, it was found that 224 (68.5%) people did not engage in physical activity on a daily basis (Table 3). The regular consumption of fruit or vegetables daily is divided into two categories, depending on whether the respondent consumes fruit or vegetables daily or not. The findings indicate that more than 95% ($n = 313$) of participants did not consume fruits or vegetables daily. More than 90% of respondents have no history of hypertension or do not take antihypertensive drugs and have no record of high blood sugar.

Based on the CANRISK questionnaire results, 133 (40.7%) of the respondents were classified as having a moderate risk of developing type 2 diabetes mellitus over the next ten years. When gender is considered, 43 (43.4%) female respondents have a low-risk level, while 91 (39.9%) of male respondents have a moderate risk level for developing type 2 diabetes mellitus in the next ten years. This study found a significant difference ($p = 0.000$) between male and female respondents, history of hypertension ($p = 0.000$), family history of diabetes mellitus ($p = 0.001$), and educational level ($p = 0.001$) in the risk categoryof developing type 2 diabetes based on the CANRISK questionnaire. People living with type 2 diabetes are usually over 40 years but may also occur at ages over 20 (Wu et al. 2014). The study results showed a significant positive association between age and the overall CANRISK score (type 2 diabetes risk) ($p = 0.000$; r = 0.511). The findings also showed a significant positive correlation between the size of waist circumference ($p = 0.000$; r = 0.673) and the BMI score ($p = 0.000$; r = 0.657) with the total CANRISK questionnaire score risk of developing type 2 diabetes for the next ten years).

Table 1 Demographic characteristics of participants

Characteristics	n (%)
Age	
≤ 44 yr.	204 (62.4)
45–54 yr	102 (31.2)
55–64 yr	21 (6.4)
Gender	
Male	228 (69.7)
Female	99 (30.3)
Education	
Primary	4 (1.2)
Secondary school	4 (1.2)
Senior High school	103 (31.5)
Diploma	47 (14.4)
Undergraduate	163 (49.8)
Postgraduate	3 (0.9)
Professional degree	3 (0.9)

Table 2 Physical characteristics of participants

Characteristic	Mean±SD
Body mass index (BMI)	
Female	26.3±4.9
Male	25.7±4.6
Weight (kg)	
Female	63.3±12.8
Male	70.1±13.2
Height (cm)	
Female	155.2±4.9
Male	165.3±6.2
Weight circumference (cm)	
Female	87.5±9.8
Male	90.9±10.7

Discussion

A wide variety of lifestyle factors are also of considerable significance for the development of type 2 diabetes (Wu et al. 2014), such as sedentary lifestyle (Zimmet et al. 2001), physical inactivity (Hu et al. 2001), smoking (Śliwińska-Mossoń and Milnerowicz 2017), and alcohol intake (Cullmann et al. 2012). In addition, there are other factors, such as hypertension, ethnicity, blood sugar disorders, and a history of giving birth to babies weighing more than 4 kg, which are considered risk factors for developing type 2 diabetes (Wu et al. 2014). The CANRISK also included the above risk factors in the questionnaire. Thus, each question's item score is totaled, and the overall score is classified into three categories: low, medium, and high for developing type 2 diabetes over the next ten years.

Table 3 Questionnaire CANRISK items

No	Variable	Categories	n (%)
1	Age group	≤ 44 years	204 (62.4)
		45–54 years	102 (31.2)
		55–64 years	21.(6.4)
		65–74 years	0 (0)
2	Gender	Female	99 (30.3)
		Male	228 (69.7)
3	BMI		
	Female	Normal/underweight (<25)	48 (48.5)
		Overweight (25–29)	30 (30.3)
		Obesity, non-morbid (30-34)	13 (13.2)
		Obesity, morbid (≥ 35)	8 (8.0)
	Male	Normal/underweight (<25)	106 (46.5)
		Overweight (25–29)	84 (36.8)
		Obesity, non-morbid (30-34)	30 (13.2)
		Obesity, morbid (≥ 35)	8 (3.5)
4	Waist circumference		
	Female	< 80 cm	20 (20.2)
		80–88 cm	35 (35.4)
		>88 cm	44 (44.4)
	Male	< 94 cm	144 (63.2)
		94–102 cm	50 (21.9)
		> 102 cm	34 (14.9)
5	Daily physical activity ≥ 30 mins	Yes	103 (31.5)
6	Daily physical activity ≥ 30 mins	Everyday	144 (63.2)
7	Eat vegetables or fruits	Yes	14 (4.3)
8	History of of high blood pressure	Yes	23 (7.0)
9	History of given birth to a large baby weighing 4.0 kg or more ≥	Yes	8 (2.4)
		No or I do not know	319 (97.6)

Obesity is caused by an overabundance of adipose tissue, which is one of the most serious risks of type 2 diabetes. Overweight and obesity have a negative impact on both physical and psychosocial health and well-being (Naser et al. 2006). Obesity is regarded as a public health emergency in both developed and developing countries (Gallagher et al. 2000). Almost two-thirds of the adult population in the United States are considered overweight or obese. Similar patterns can be found all over the world (Tsai et al. 2011). Obesity has been linked to a variety of medical, psychological, and social conditions, the most serious of which could be type 2 diabetes. At the turn of the century, it was estimated that 171 million people had type 2 diabetes, a figure that is expected to rise to 360 million by 2030 (McKeigue et al. 1991). Insulin resistance is linked to type 2 diabetes and obesity. Despite being insulin resistant, most obese people do not have hyperglycemia. Under normal conditions, pancreatic cells of the islet of Langerhans release enough insulin to compensate for insulin decreases while maintaining normal glucose tolerance (Chawla et al. 2016; Fowler 2008).

One piece of evidence reviewed compared the quantitative results of all available epidemiological studies and indicated that abdominal obesity, as measured by a variety of tests, significantly increases the risk of type 2 diabetes in a variety of ethnic groups. Despite differences in the adjustment factors, both cohorts were adjusted for age and weight for BMI, which we did not consider to be a measure of abdominal obesity. This adds confidence in the overall finding that, on average, increased abdominal obesity raises the risk of type 2 diabetes by more than twofold (Freemantle et al. 2008). The correlation between abdominal obesity and diabetes appears to be biologically plausible. Abdominal fat is thought to increase the risk of diabetes through a variety of secreted factors, including non-esterified fatty acids and adipocytokines, such as tumor necrosis factor-α and decreased adiponectin. Reduction in waist circumference is associated with increased circulating levels of these adipose tissues secreted factors. Thus, reducing waist circumference can also lead to a lower risk of diabetes development, as shown in some research on

obesity and lifestyle in those at risk for type 2 diabetes (Knowler et al. 2002; Tuomilehto et al. 2001).

Regular physical activity can help to reduce the risk of diabetes because it increases lean mass while decreasing fat in the body. With physical activity, insulin levels rise, causing blood sugar levels to fall. If a person does not exercise or participate in sports on a regular basis, food substances that enter the body are not burned but are stored as fat and sugar. Diabetes can result if the pancreatic condition is insufficient to produce insulin and insufficient to convert glucose into energy (Colberg et al. 2010). A person's low intake of fruits and vegetables is linked to an increase in body weight and the occurrence of type 2 diabetes (Bhattacherjee et al. 2015). Consuming fiber-rich foods is critical for diet control and weight maintenance or loss. According to the CANRISK score, people who consume fruit or vegetables every day or not have a moderate risk of developing type 2 diabetes. This is because, despite the fact that respondents consume vegetables or fruit on a daily basis, the researchers had no idea how many slices or fruits were consumed, nor did they know what type.

Although most countries have high rates of undiagnosed diabetes and prediabetes, the assessment tools currently used to estimate an individual's risk of diabetes are inadequate. Most prognostic risk-scoring models for detecting type 2 diabetes require specific blood test results, which may limit their widespread use in the community. A risk assessment questionnaire can be used in addition to blood glucose testing. The method of screening risk factors with a questionnaire is intended to develop a simpler, more practical, and informative screening process for identifying the risk of developing type 2 diabetes mellitus. Several countries have developed diabetes risk assessment tools that rely solely on information that a participant can self-complete without detailed knowledge or specific laboratory test values. Several diabetes risk screening tools have been made, such as, the Australian type 2 Diabetes Risk Assessment Tool (AUSDRISK) (Wong et al. 2011), the Finnish Diabetes Risk Score (FINDRISC) (Hellgren et al. 2012; Martin et al. 2011; Štiglic et al. 2016), and the CANRISK and Deutscher Diabetes-Risiko Test (DIfE) (Deutsches Institut für Ernährungsforschung 2019).

The FINDRISC is a critical component of Finland's national diabetes prevention program, which has so far successfully screened over 10% of the Finnish population. In Finland, FINDRISC has been used to identify high-risk individuals who could benefit from interventions or who should be investigated further using the oral glucose tolerance test (OGTT). Among those identified as being at high risk of developing diabetes by the Finnish study, 60% of men and 45% of women had abnormal glucose tolerance at baseline (Saaristo et al. 2010). However, the generalizability of FINDRISC is limited by Canada's different ethnic make-up from that of Finland. As a result, Canadian diabetes experts modified FINDRISC to include ethnicity as well as other important variables (gender, education, and macrosomia) to develop the CANRISK (Kaczorowski et al. 2009). Age, BMI, waist circumference, physical activity, fruit/vegetable consumption, history of high blood pressure, history of high blood glucose, family history of diabetes, sex, ethnicity, maternal history of macrosomia, and education are all terms in the CANRISK model. Four of these terms were not included in the original FINDRISC scoring metric (sex, ethnicity, macrosomia, and education). In this study, we discovered that CANDRISK is quite reliable and simple to use in Indonesia. However, there is no data on which screening tools are more accurate in determining an individual's risk of developing type 2 diabetes. Additional research would be required to assess the acceptability of CANRISK and other risk assessment tools in the clinical setting. The actual cost of screening for diabetes mellitus risk using a risk assessment questionnaire will also be required.

This study used a cross-sectional design that was more effective and reliable in gathering data than other study designs to determine the level of risk for developing type 2 diabetes over the next ten years. Type 2 diabetes risk assessment research remains uncommon in Indonesia, particularly when the CANRISK questionnaire is used as a risk assessment tool. Furthermore, this study's findings can help prevent the development of type 2 diabetes in a high-risk population. However, more research is required to determine the role of the healthcare professionals in the community, including pharmacists. The provision of information and education during the counselling session, particularly for those with chronic diseases such as diabetes mellitus, may reduce barriers to medication adherence.

Conclusion

In conclusion, various risk factors for diabetes mellitus, such as age, BMI, and waist circumference, have a positive association with the overall risk score for the CANRISK questionnaire. Factors with significant differences between risk factor categories and risk categories based on the CANRISK questionnaire were gender, history of hypertension, history of high blood sugar, family history of diabetes mellitus, and education level. On the other hand, there was no significant difference between the risk factor category and the risk category of developing type 2 diabetes based on the CANRISK questionnaire for physical activity, fruit or vegetable intake, ethnicity, and childbearing history ≥4.1 kg significant difference.

Author contributions EZ conceived the project idea and obtained the funding for the study. EZ further developed the study with input from AS and GN. SIKS, EER, and AP contributed to the data collection and data analysis. All authors made substantial contribution in designing the questionnaire, analyzing the data, interpretation of results, reviewing and

interpreting the results. The authors reviewed the work critically and agreed to the final approval of the work to be published.

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Availability of data and material All data related to this study was kept under the supervision of the research team.

Code availability Not applicable.

Declarations

Conflicts of interest/competing interests The authors declare that they have no conflict of interest.

Ethics declaration This manuscript has not been published or presented elsewhere in part or in entirety and is not under consideration by another journal. The study was approved by the Human Research Ethics Committee of Faculty of Public Health Universitas Airlangga, Surabaya, Indonesia (Ref: 144/EA/KEPK/2019).

Consent to participate Informed consent was obtained from all the individual participants in the study.

Consent for publication All authors have contributed significantly to the work, are aware of this submission, and agree with it.

Research involving human participants Ethical approval was obtained, and all procedures performed in this study were in accordance with the ethical standards of the Human Research Ethics Committee.

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Screening for identifying individuals at risk of developing type 2 diabetes using the Canadian diabetes risk (CANRISK) questionnaire

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Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7