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Risk Assessment of Type 2 Diabetes Mellitus Using the American Diabetes Association (ADA) Diabetes Risk Test in Residents of Bah Bolon Village, Simalungun District

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ABSTRACT

Background: The prevalence of DM Type 2 is expected to increase to 7079 per 100,000 individuals in 2030 and 7862 in 2040.Meanwhile, based on Riskesdas data, Indonesia has a prevalence of DM of 2.1% in 2013. The highest prevalence was in Deli Serdang (2.9%) and followed by Medan (2.7%), Pematang Siantar (2.2%), Asahan (2.1%), Gunungsitoli (2,1%), Simalungun (1.57%) and Mandailing Natal (0.3%). The ADA Diabetes Risk Test is a simple strategy that used for screening prediabetes and diabetes in asymptomatic adults. Simalungun Regency is one of the 10 districts with a high prevalence of DM after Medan, Pematang Siantar and Asahan.Bah Bolon Village is one of the villages located in Dolog Masagal District.Bah bolon village is a remote village and far from the city and health facilities covering 342 heads of families. Aim of study is to know about how much risk factor of DM type 2 in Simalungun Distric using ADA Diabetes Risk Test.
Methods: This study is analytical with a cross-sectional retrospective design. Data were analyzed after distribution test, then mean difference and correlation test was using the SPPS program where p <0.05 was considered statistically significant.
Result: This study showed that the prevalence ratio of the ADA Diabetes Risk Test was 3.04 which indicates that there is an increased risk of DM 3 times compared to individuals who have a low risk ADA Diabetes Risk Test score. The highest prevalence ratio is a history of hypertension. A history of hypertension increases the risk of developing T2DM sixfold. A history of hypertension has a 95% CI value of 2.19-17.84 which indicates that people with hypertension have a 2.19 to 17.84 times higher risk of developing T2DM.
Conclusions: The significant association DM about 3 times in ADA Diabetes Risk Test between high score and low score, significant association between hypertension history with hyperglycemia.

Keywords: DM Type 2, Risk Factors, ADA Diabetes Risk Test, Screening DM

INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycaemia that occurs due to defects in insulin secretion, insulin action or both.[1] Conditions in which hyperglycaemia due to insulin resistance and/or insufficiency of insulin in target tissues is estimated to be the 9th cause of death in the world. DM has a prevalence of 6.28% or around 462 million individuals in the world. The prevalence of DM is expected to increase to 7079 per 100,000 individuals in 2030 and 7862 in 2040.[3] The 2018 Riskesdas data explains that the national DM prevalence has increased by 10.9% and is highest in rural areas 11.2%. Diabetes with its complications is the third highest cause of

death in Indonesia. The percentage of deaths from diabetes in Indonesia is the second highest after Sri Lanka.[8]

DM risk factors consist of modifiable risk factors and non-modifiable risk factors. Risk factors for DM that cannot be modified are age, genetics, history of giving birth to a baby with a low birth weight >4000 grams or a history of having had gestational diabetes, a history of being born with a low birth weight <2500 grams, race and ethnicity. Modifiable risk factors are related to lifestyle and diet, namely obesity with a BMI ≥ 23 kg/m2, hypertension, dyslipidaemia, smoking habits, lack of physical activity and consumption of foods high in carbohydrates and low in fibre.[1] In addition, obesity, alcohol consumption, sedentary life style and dietary factors are risk factors. which can be modified the most to increase the risk of developing DM.[2]

The ADA Diabetes Risk Test is a simple strategy used according to the American Diabetes Association (ADA) to be used as an additional option for screening prediabetes and diabetes in asymptomatic adults.[5] According to previous studies it was said that the ADA Diabetes Risk Test score has high sensitivity and can done in a simple way. The other risk factors assessed by the ADA Diabetes Risk Test are male gender, age, history of gestational DM, hypertension, sedentary life style.[6]

The results of the ADA Diabetes Risk Test in Indonesia showed that the use of the ADA Diabetes Risk Test had a sensitivity in diagnosing hyperglycaemia of 68% and a specificity of 65% with a cut off = 5 for the diagnosis of hyperglycemia. If the score is ≥4, the sensitivity increases to 93% with a negative predictive value of 9.7%.[9]

Simalungun Regency is one of the 10 districts with a high prevalence of DM after Medan, Pematang Siantar and Asahan Districts. Bah Bolon Village is a village located in Dolog Masagal District, Simalungun Regency. Bah bolon village is a remote village and far from the city and health facilities covering 342 heads of families. Researchers aim to assess the risk of Type 2 DM (DMT2) in residents of Bah Bolon Village, Simalungun Regency by using the ADA Diabetes Risk Test.

MATERIALS & METHODS

The research was conducted in Bah Bolon Village, Simalungun Regency. The time of the research was carried out in October 2022. The research design was observational analytic with a cross-sectional approach to prove the risk of T2DM using the ADA Diabetes Risk Test in residents of Bah Bolon Village, Simalungun Regency. To calculate the minimum sample size of this study, the following minimum population proportion formula is used:

$$n = \frac{(Z_{(1-\alpha/2)})^2 \times (1-p)}{d^2}$$

n = research sample size

d = the precision expected by the researcher is 10%

Z1-α/2 = Type I error which is 95% (Z=1.96)

p = Prevalence of cases of hyperglycemia in Indonesia

Based on the calculations above, the minimum sample size required in this study was 92 patients. With the inclusion criteria, the sample is a population aged ≥ 35 years who live in Bah Bolon Village, Simalungun Regency who are willing to participate in the research by signing written informed consent and will be subjected to anthropometric examination, namely measuring abdominal circumference and will be assessed using the ADA Diabetes Risk Test. The exclusion criteria in this study were residents of Bah Bolon Village with a history of previous DM and T2DM therapy, patients with incomplete history and physical examination data.

All samples will be taken for personal history (name, age and gender) and then an assessment will be carried out using the ADA Diabetes Risk Test. After that an anthropometric examination will be carried out, such as weight, height and waist circumference. Then in the study sample, the ADA risk screening test score was

assessed and the score was added up, if the score is ≥5 then there is a high risk of suffering from T2DM. Then check the sample waist circumference. Blood samples were examined using the Rapid Glucose Stick Easy Touch test to see the results of the blood glucose test at the time. Furthermore, data collection and data analysis were carried out.

Sample Demography

Variable	Mean ± SD (Min-Max)	n	(%)
Gender			
Male		40	40,0
Female		60	60,0
Age	53.5 (27-77)		
History of Gestational DM			
Yes		8	8,0
No		92	92,0
History of DM in Family			
Yes		42	42,0
No		58	58,0
History of Hypertension			
Yes		41	41,0
No		59	59,0
Physically Active			
Yes		21	21,0
No		79	79,0
Anthropometry Waist size (cm)	79 (28-108)		
Weight (kg)	61,58±12,81		
Height (cm)	156,09±8,93		
BMI (kg/m^2)	25,33±5,17		
Nutritional Status			
Normal		27	27,0
Overweight		54	54,0
Obesity		19	19.0

Table 1. Frequency distribution of research subjects based on demographic characteristics and risk factors for DMT2 based on the ADA Diabetes Risk Test.

STATISTICAL METHODS

The data will be analyzed descriptively for the distribution of sample frequencies based on characteristics. The normality test was carried out by the Kolmogorov-Smirnov test. To assess numerical variables using the independent T-test if the distribution is normal and the Mann Whitney test is carried out if the distribution is not normal. To assess categorical variables using the Chi-Square test. If the Chi-Square does not meet the requirements, the Fisher-Exact test will be used. The analysis was performed using statistical software. Results are declared significant when $p < 0.05$.

RESULT

Based on the table above shows that most of the respondents are female with a median age of 53.5 years. Only a small proportion of respondents had a history of pregnancy during diabetes mellitus (8%) and a small proportion had a family history of diabetes mellitus (42%). In this study, only 41% of respondents had a history of hypertension and more did not exercise actively (79%) and 19% of respondents were obese with a median waist circumference of 79 cm (28-108cm). The average respondent weighs 63 kg with a height of 158 cm.

Based on the analysis of normality and homogeneity, it shows that weight, height, and body mass index have a normal and homogeneous distribution, so that it is continued with an independent t-test. Other numerical data such as age and waist circumference have an abnormal distribution and are not homogeneous, so it is continued with the Mann Whitney test. Categorical data in this study were analyzed using Chi-square.

Variable	Hyperglycaemia (n=23)	Normal (n=77)	*p-value*
Gender			
Male	7 (7,0)	33 (33,0)	0,286[c]
Female	16 (16,0)	44 (44,0)	
Age	56,70±12,65	50,10±12,52	0,036[b]
History of Gestational DM			
Yes	2 (2,0)	6 (6,0)	0,889[c]
No	21 (21,0)	71 (71,0)	
History of DM in Family			
Yes	12 (12,0)	30 (30,0)	0,260[c]
No	11 (11,0)	47 (47,0)	
History of Hypertension			
Yes	17 (17,0)	24 (24,0)	0,000[c]
No	6 (6,0)	53 (53,0)	
Physically Active			
Yes	5 (5,0)	16 (16,0)	0,921[c]
No	18 (18,0)	61 (61,0)	
Anthropometry Waist size (cm)	82,43±11,71	78,49±12,45	0,270[b]
Weight (kg)	64,35±10,51	60,75±13,37	0,240[a]
Height (cm)	157,04±8,23	155,81±9,16	0,562[a]
BMI (kg/m^2)	26,12±4,10	25,10±5,45	0,411[a]
Nutritional Status			
Normal	9 (9,0)	35 (35,0)	
Overweight Obesity	9 (9,0)	20 (20,0)	
History of DM in Family	5 (5,0)	22 (22,0)	0,467[c]

Table 2. Frequency distribution of study subjects based on random blood glucose. a, Independent t-test; b, Mann Whitney; c, Chi-square

Variable	Hyperglycaemia (n=23)	Normal (n=77)	PR	Cl 95%
Male				
Yes	7 (7.0)	33 (33,0)	0,583	0,215-1,58
No	16 (16,0)	44 (44,0)		
History of Gestational DM				
Yes	2 (2,0)	6 (6,0)	1,12	0,212-6,00
No	21 (21,0)	71 (71,0)		
History of DM in Family				
Yes	12 (12,0)	30 (30,0)	1,7	0,66-4,36
No	11 (11,0)	47 (47,0)		
History of Hypertension				
Yes	17 (17,0)	24 (24,0)	6,25	2,19-17,84
No	6 (6,0)	53 (53,0)		
Physically Active				
Yes	5 (5,0)	16 (16,0)	1,05	0,341-3,29
No	18 (18,0)	61 (61,0)		
Nutritional Status				
Normal	9 (9,0)	35 (35,0)	0,69	0,229-2,10
Overweight	9 (9,0)	20 (20,0)		
Obesity	5 (5,0)	22 (22,0)		

Table 3. The relationship between the risk factors listed in the ADA Diabetes Risk Test and random blood glucose

Table 3 shows that the variables that have a high prevalence ratio are history of hypertension, family history of T2DM, history of DM during pregnancy and inactive sports. The highest prevalence ratio is a history of hypertension. A history of hypertension increases the risk of developing T2DM sixfold. A history of hypertension has a 95% CI value of 2.19-17.84 which indicates that people with hypertension have a 2.19 to 17.84 times higher risk of developing T2DM. Variables that increase the risk of developing DMT2 are a family history of diabetes which increases the risk of 1.7 times the incidence of DMT2, while a history of diabetes during pregnancy is 1.12 times, while obesity increases the incidence of DMT2 1.05 times.

Variable	WC increased (n=29)	WC Normal (n=71)	*p-value*
Gender			
Male	18 (40)	22 (60)	
Female	11 (18,3)	49 (81,7)	0.007[c]
Age	56,70±12,65	50,10±12,52	0,611[c]
History of Gestational DM			
Yes	3 (27,2)	8 (72,8)	0.427[c]
No	6 (12,2)	43 (87,8)	
History of DM in Family			
Yes	16 (38,0)	26 (62,0)	0.138[c]
No	13 (22,4)	45 (77,6)	
History of Hypertension			
Yes	14 (34,1)	27 (65,9)	0.470[c]
No	15 (25,4)	44 (74,6)	
Physically Active			
Yes	6 (28,6)	15 (71,4)	0.824[c]
No	23 (29,1)	56 (70,9)	
Anthropometry			
Weight (kg)	69 (38-98)	57 (35-89)	0,253[a]
Height (cm)	160 (142-176)	158 (133-170)	0,061[b]
BMI (kg/m^2)	25 (17,59-39,69)	25 (15,2-38,05)	0,062[b]
Nutritional Status			
Normal	6 (20,7)	38 (53,5)	0.001[c]
Overweight Obesity	11 (37,9)	8 (11,3)	
Anthropometry Waist size (cm)	12 (41,4)	25 (35,2)	

Table 4. The relationship between the risk factors listed in the ADA Diabetes Risk Test and waist circumference

T2 DM risk analysis

Variable	Hyperglycaemia (n=23)	Normal (n=77)	PR	Cl 95%
ADA Score				
High Risk	16	33	3,04	1,12-8,25
Low Risk	7	44		

Table 5. T2 DM risk analysis based on the relationship between the ADA Diabetes Risk Test score and blood glucose at the time.

Variable	Hyperglycaemia (n=23)		Normal (n=77)	PR	Cl 95%
	Waist Circumference				
Normal	15		56	1,30	0,622-2,74
Increased	8		21		

Table 6. T2 DM risk analysis based on the relationship between blood glucose at the time of waist circumference.

Based on table 4, it can be seen that female gender and obesity are risk factors listed in the ADA Diabetes Risk Test component which have a significant relationship to increased waist circumference. Meanwhile, family history of DMT2, history of DM in pregnancy, history of hypertension and inactive exercise habits do not have a significant relationship with increased waist circumference.

Based on table 5 it can be seen that the high risk ADA Diabetes Risk Test score can cause hyperglycemia by 3.04 times.

Based on table 6, it shows that the increase in waist level increases 1.30 times the occurrence of hyperglycaemia.

DISCUSSION

This study consisted of 100 respondents who were divided into two groups, namely the group with high blood sugar levels (hyperglycaemia) with a total of 23 respondents and the group with normal blood sugar levels with a total of 77 respondents. Most of the research respondents are female. In women, a decrease in the hormone oestrogen will increase insulin resistance. This is due to decreased oestrogen increasing lipogenesis thus inducing insulin resistance. Oestrogen is also known to reduce gluconeogenesis through the Foxo1 pathway.[1]

In previous studies it was stated that hypertension in DMT2 had a prevalence of around 59%. DMT2 in the long term can exacerbate hyperglycaemia, dyslipidaemia and insulin resistance. In DM there are microvascular changes, sympathetic nerve damage and an increase in the renin-angiotensin system which can exacerbate the state of hypertension. In addition, increasing age also increases the vascular stiffness.[11]

In this study, the prevalence ratio of the ADA Diabetes Risk Test was 3.04 which indicates that there is an increased risk of DM 3 times compared to individuals who have a low risk ADA Diabetes Risk Test score. The results of this study are in line with previous research in Indonesia. The results of this study indicate that the use of the ADA Diabetes Risk Test can detect an individual's risk of developing DMT2.[9] Another study in Saudi Arabia showed that the results of this screening indicated that these individuals had a high risk of developing DM.[7]

A history of pregnancy with diabetes mellitus has a prevalence ratio of 1.12. These results are in line with previous research which stated that gestational diabetes mellitus increases the risk of developing DMT2 compared to other variables.[12] In this study, obesity has a prevalence ratio of 0.69 which indicates that there is a reduced risk of DM in obese patients. However, other studies have shown that obesity increases the risk of DMT2 through increased insulin resistance.[13] Other studies also suggest that obesity increases the risk of DMT2.[14] The difference in these results is thought to be caused by differences in the definition of obesity, namely differences in body mass index and waist circumference.

In this study, it was found that increased waist circumference had a 1.3 times the risk of developing T2DM. This result is supported by previous research which showed that there was a relationship between body mass index and waist circumference and the risk of developing DMT2. female.[15] Other studies have also shown that patients with obesity and waist circumference > 88 cm have a 1.58 to 2.04 probability of having DMT2.[16] Previous studies have also shown that body mass index value is a predictor of DMT2 with a relative risk of 1.39 [1.06 -1.82].[17]

This study shows that waist circumference is related to nutritional status obtained from the calculation of body mass index. This is due to the condition of obesity where there is an accumulation of subcutaneous fat in the waist circumference and arm circumference and is accompanied by an increase in body weight.[18] This study shows that waist circumference is not related to the ADA Diabetes Risk Test. Other components such as history of pregnancy with DM, family history, hypertension, and gender are not related to waist circumference. In this study showed no correlation between waist circumference and blood glucose during. This is thought to be due to the initial condition of T2DM, obesity often occurs, but in long-standing T2DM patients, there is a decrease in subcutaneous fat due to the lipolysis process.[19]

In addition, in this study, T2DM sufferers were older than normal, so they had different physiological responses. This is reinforced by previous studies which revealed that type 2 DM mostly affects the older age group with a range (60-64 years) which was tested using 3953 respondent, this can be done because the physiological response can also be caused by differences in gender.[20] The strength of this study is that it discusses the risk of developing T2DM based on the ADA Diabetes Risk Test score. Limitations in this study include data that only reflects one area and cannot be universally represented and data related to varied samples makes too much bias in this study.

CONCLUSION

History of hypertension was the dominant risk factor that had an effect of 6.25 times increase on the incidence of DMT2, followed by a risk factor of family history of

DMT2 which had an effect of 1.7 times increase on the incidence of DMT2. Female gender and obesity, which are the components listed in the ADA Diabetes Risk Test, have a significant relationship to the incidence of T2DM. The high risk ADA Diabetes Risk Test score can predict the increase of hyperglycaemia 3.04 times. Increased waist circumference has 1.30 times the risk of developing T2DM.

Declaration by Authors

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