Prediabetes Screening with American Diabetes Association (ADA) Scoring in the Primary Health Care Yogyakarta

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ABSTRACT

Background: Numerous studies have shown an increase in prediabetes incidence from the time being. Some of the prediabetes screening methods that can be performed at primary health care were the American Diabetes Association (ADA) scoring for prediabetes. However, there was no data that describes the validity and applicability of the ADA scoring on prediabetes patients in Indonesia. **Objective**: To describe prediabetes screening and to find out the applicability of the ADA scoring method in Yogyakarta primary health care. **Method**: The diagnostic test by the scoring system of the ADA questionnaire was compared with OGTT (oral glucose tolerance test) as the gold standard. The subjects were patients of primary health care in Yogyakarta who fulfill the inclusion and exclusion criteria. **Result**: The subjects were 279 respondents with 227 females (81.4%) and 52 male patients (18.6%). The mean age of the study subjects was 50.4 years (SD 12.81). The sensitivity and specificity of the scoring method of ADA was 61% and 71%. This could be influenced by the difference in BMI standard as one of the scoring items. After some item scoring points were modified, namely gender point value and BMI classification, the sensitivity of the scoring method was higher, from 61% to 81% and the specificity decreased from 71% to 63%. **Conclusion**: Prediabetes prevalence was 11.1% in the study population. The sensitivity and specificity of the scoring method of ADA is 61% and 71%. The scoring method of ADA could not be used in primary health care.

Keywords: ADA, primary health care, prediabetes, risk factor scoring, screening

INTRODUCTION

Numerous studies have shown an increasing incidence rate and prevalence of prediabetes over time. More than 470 million people estimated will experience prediabetes by 2030[1]. Prediabetes prevalence in Southeast Asia is estimated at 6.8%[2]. The research of Suwondo and Pramono shows that the prevalence of prediabetes (GDPT) in Indonesia is 10%[3]. This prevalence is estimated to increase to 20.6% by 2025[2]. The highest prevalence of prediabetes was 38-47 years old at 25.8%, and at age ≥ 58 years was 21.9%[3].

Based on baseline health research data in 2013 the prevalence of DM in Yogyakarta Special Region (DIY) is 2.6 % and is the highest prevalence of DM in Indonesia followed by DKI Jakarta with 2.5% and North Sulawesi 2.4%[4]. Prediabetes prevalence rates in DIY are not yet known. Prediabetes prevalence in DKI Jakarta is 24.91% at 25-64 years old[5]. While the prevalence of prediabetes in Depok Java was 24.25% at age ≥ 25 years[6]. Screening should be done because the majority of people with prediabetes are unaware of the risk of diabetes[7]. The

annual risk of prediabetes patients to type 2 diabetes is 5-10%[8,9]. Some people with prediabetes also reported complications both microvascular and macrovascular[10]. Waught, Scotland, Gillet, Brennan, Goyder, Williams, and John stated screening in patients with prediabetes could prevent complications significantly in cardiovascular disease[11]. Zhang, Engelgau, Valdez, Benjamin, Cadwell, and Narayan use the cost analysis method to assess the efficacy (sensitivity and specificity) and cost-effectiveness of five prediabetes diagnostic and screening methods[12].

It has been found from these studies that TTGO has been the most efficient way. While capillary glucose testing and questionnaire scoring for risk assessment are the most effective methods. Patients prefer fasting blood glucose tests compared to TTGO. Other prediabetes screening trials were conducted using scoring techniques. Poltavskiy, Kim, and Bang compared both ADA and CDC screening results. The findings of the ADA scoring are comparatively better. AUC (Area Under Curve) ADA scores for DM are 0.77 and CDC

scores for prediabetes are AUC 0.73–0.74 and AUC 0.72–0.74 and CDC for prediabetes are 0.70–0.71[13].

A systematic review by Norris, Kansagara, Bougatsos, and Fu shows that screening of high-risk groups at primary health facilities can also reduce the progression from pre-diabetes to diabetes[14]. This can be reduced due to previous interventions in pre-diabetes patients, such as lifestyle changes and pharmacological therapy. Besides, studies on dietary modification show that prediabetes converts to normal glucose tolerance or normoglycemia[15]. Prediabetes is one of the health problems that must be detected and intervened earlier in primary health facilities. One way is through screening. Research on screening for prediabetes in Indonesia has not been done much. Screening with ADA scoring is one of the methods that is often used and has a good and effective level of accuracy in several countries. The use of this method has not been widely used in Indonesia, especially in primary services. Therefore, this research needs to be carried out which can describe effective and efficient screening methods for prediabetes at primary health facilities. So, how a description of a prediabetes screening at DIY primary health care facilities using the ADA scoring method?

RESEARCH METHOD
This type of research is an analytic observational study. The approach taken is based on the diagnostic test of the ADA Prediabetes Test Scoring System compared to TTGO as the gold standard. All patients ≥ 25 years of age in primary health care facilities at DIY were in the study population. The selection of the sample is performed by cluster sampling. The inclusion criteria for this study are as follows: age ≥ 25-85 years, willing to follow research with informed consent, able to communicate well. Although the exclusion criteria are as follows: diagnosed with DM, diagnosed with gestational DM. The study was performed in April-May 2017. This research was conducted in April-May 2017. The study was conducted in three primary health care facilities in Yogyakarta. Respondents were recruited by health cadres in the community. Respondents go through 2 processes before becoming a respondent. The first stage of the respondent filled out questions related to the history and status of DM and treatment. The second stage of the respondent followed the examination of capillary glucose checks and the results of fasting venous blood glucose.

This instrument comes from the ADA Prediabetes Screening Test13. This questionnaire will first be translated into Indonesian by an official translation body and then tested for validity and reliability. If the result score is 0-3, then the patient is declared to have a low risk of prediabetes if the total score is ≥ 4, then the patient is interpreted as a patient who is currently at high risk of having prediabetes, and is at high risk for having diabetes in the future. Data processing, statistical analysis, and hypothesis testing were carried out with the SPSS 2.

RESULTS
The study was conducted in two regencies in DIY, namely two primary health care center working areas in the Sleman regency and one Bantul regency working area, *Puskesmas* Tempel, *Puskesmas*Kalasan, and *Puskesmas* Kasihan I. A total of 346 respondents was willing to become research

samples after being given an informed consent explanation. However, as many as 67 people were excluded from the study because 18 patients had a history of DM from the results of history taking and 59 patients were diagnosed with DM from fasting blood sugar and blood sugar based on glucose meter.
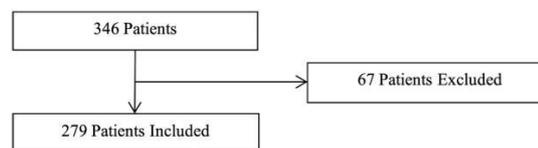

Diagram 1. Enrolment patient

A total of 279 respondents with 227 female respondents (81.4%) and 52 male respondents (18.6%). The average age was 50.4 years (SD 12.81). The average weight and height of the respondents was 58.3 kg (SD 11.4) and 152.6 cm (SD 7.41). As many as 47% (131 respondents) were included in the normal (BMI 18.5-24.99 kg/m2). However, 35.8% were included in the pre-obesity/overweight ratio (BMI 25.00-29.99 kg / m2). The mean abdominal circumference for all respondents was 86.1 cm. The prevalence of prediabetes in this study was 11% (31 out of 279 subjects).

The method used in this study was a questionnaire based on the ADA. The questionnaire was translated into Indonesian by the Faculty of Cultural Sciences Translation Department of the Gadjah Mada University and tested for validity and reliability. The questionnaire was distributed to 30 respondents and the results were analyzed. The validation test used in this study is Pearson's bivariate correlation (Pearson product-moment). The bivariate Pearson correlation test results obtained by each question item have a value of r greater than the r table (r: 0.306). Pearson bivariate correlation test criteria on is if r arithmetic > r table (2-sided test with sig. 0.05), then the instrument or question items are significantly correlated with the total score (declared valid). Meanwhile, if, on the contrary, it has been declared invalid. Therefore, all questions in the questionnaire are valid from the results of the validity test.

From the 2x2 table calculation, the sensitivity of the ADA score method is 61%, which means that 61% of prediabetes patients are categorized as having a high risk of prediabetes at present based on the ADA score method. The specificity of the ADA score method is 71 percent, which means that 71 percent of healthy subjects are currently categorized as not at high risk of prediabetes based on the ADA score method.

Table 2. Table diagnostic test scoring method of ADA

Scoring System of ADA	Prediabetes		Total
	Yes	No	
Prediabetes	19	72	91
Normal	12	176	188
Total	31	248	279

Sn: 61%;Sp: 71%; PPV: 21%; NPV: 94%; LR+: 2.11; LR-: 0.55;Accuration = 69.8%

The positive predictive value of this scoring method is 21%, meaning that the probability of subjects suffering from prediabetes if categorized as having prediabetes by

Table 1. Characteristics of the research subject

Characteristic	Frequency	Percentage*
Gender		
Female	227	81.4%
Male	52	18.6%
Age		
Mean and SD	50.4 years old (SD 12.81)	
Minimum and Maximum	25 and 84 years old	
Classification Age		
< 40 years	66	23.7%
40-49 years	61	21.9%
50-59 years	85	30.5%
≥ 60 years	67	24.0%
Weight		
Mean and SD	58.3 kg (SD 11.4)	
Height		
Mean and SD	152.6 cm (SD 7.41)	
Body Mass Index (BMI)		
Underweight	15	5.4%
Normal weight	132	47.3%
Pre-Obese	100	35.8%
Obesity Class I	25	9.0%
Obesity Class II	5	1.8%
Obesity Class III	2	0.7%
Mean and SD BMI	25.6 kg/m^2 (SD 10.6)	
Gestational DM History		
No	276	98.9%
Family History of DM		
No	191	68.5%
Yes	88	31.5%
Hypertension		
No	177	63.4%
Yes	102	36.6%
Physical Activity based on Questionnaire		
Yes	279	100%
Scoring ADA		
Mean and SD	2.75 (SD 1.68)	
Minimum	0	
Maximum	7	
Prediabetes Scoring based on ADA		
Normal (score 0-3)	188	67.4%
Prediabetes (score 4-11)	91	32.6%
Prediabetes Scoring by ADA with Modifications*		
Normal (score 0-3)	162	58%
Prediabetes (score 4-11)	117	42%
Prediabetes based on OGTT		
Normal	248	88.9%
Prediabetes	31	11.1%

* Amount divided by the total subject of research

** Modification value of sex, BMI classification

the ADA scoring method is 21%. The negative predictive value is 94 percent, meaning that the probability of the subject not suffering from prediabetes if the test is categorized as not having the risk of prediabetes by the ADA scoring method is 94 percent. The positive likelihood ratio (LR+) is 2.11, which means a comparison between the numbers of patients who have prediabetes risk at present with the ADA scoring method in the prediabetes group compared to patients who have prediabetes risk with the ADA scoring method in the healthy subject group. The positive predictive value of this scoring method is 21%, meaning that the probability of subjects suffering from prediabetes if categorized as having prediabetes by the ADA scoring method is 21%. The negative predictive value is 94%, meaning that the probability of the subject not suffering from prediabetes if the test is categorized as not having the risk of prediabetes by the ADA scoring method is 94%. The positive likelihood ratio (LR +) is 2.11, which means a comparison between the number of patients who have prediabetes risk at present with the ADA scoring method in the prediabetes group compared to patients who have prediabetes risk with the ADA scoring method in the healthy subject group. A negative likelihood ratio (LR-) of 0.55 means a comparison between patients who do not have the current risk of prediabetes in the prediabetes group compared to those who do not have a prediabetes risk with the current ADA scoring method in the healthy subject group. The accuracy or accuracy of the ADA scoring method is 69.8%.

Tabel 3. Table diagnostic test scoring method of ADA with modification

Scoring System of ADA	Prediabetes		Total
	Yes	No	
Prediabetes	25	92	117
Normal	6	156	162
Total	31	248	279

Sn: 81%; PPV: 21%; Sp: 63%; NPV: 96%; LR+:2.17; LR-:0.31; Accuration= 64.8%

The sensitivity value is quite low as a screening tool, it becomes an opportunity to change values or points on several scoring items and be simulated in this research data. After some item scoring points were modified, namely gender point value and BMI classification, the sensitivity of the scoring method was higher, from 61% to 81% and the specificity decreased from 71% to 63%. The positive forecast value of this scoring method is 21% remains the same. The negative predictive value is higher, from 94% to 96%. Positive Likelihood Ratio (LR +) is higher from

2.11 to 2.17. While the Negative Likelihood Ratio (LR-) decreased from 0.55 to 0.31. The accuracy or accuracy of the ADA scoring method decreased from 69.8% to 64.8%.

DISCUSSION

The prevalence of prediabetes at the age of 25-85 years in DIY based on the data of this study is 11.1%. This is not much different from the results of Soewondo and Pramono's research which is 10%[3]. Meanwhile, according to IDF (International Diabetes Federation) data, the prevalence of prediabetes in Southeast Asia is estimated to be around 6.8% (lower 4.2%)[2]. This might occur due to differences in the demographic characteristics of the research subjects. Yunir's study states that the prevalence of prediabetes at the age of 25-64 years in DKI Jakarta is 24.91%[5]. Besides, the prevalence of prediabetes in Depok West Java is also not much different is 24.25% at the age of 25 years old[6]. This is different from the results of this study because of differences in demographic characteristics of research subjects such as the age range, gender proportion, and the possibility of socioeconomic and cultural factors.

Table 4. Differences method of scoring ADA

Item Question	Original Version	Modified Version
1. Age Category	< 40 years old (0 point) 40-49 years old (1 point) 50-59 years old (2 points) > 60 years old (3 points)	Not Modified
2. Gender	Male (1 point) Female (0 point)	Male (0 point) * Female (1point)
3. Family History of DM	Yes (1 point) No (0 point)	Not Modified
4. Hypertension	Yes (1 point) No (0 point)	Not Modified
5. Physical Activity	Yes (0 point) No (1 point)	Not Modified
6. Weight Status	< 27.5 kg/m^2(0 point) 27.5-32.49kg/m^2 (1 point) 32.50-44.00kg/m^2(2 points) ≥44.00 kg/m^2(3 points)	< 25.0 kg/m^2(0 point) * 25.0-27.49kg/m^2 (1 point) 27.50-32.49kg/m^2(2 point) ≥32.50 kg/m^2(3 point)

From the 2x2 table calculation, the sensitivity and specificity of the ADA scoring method (with a score ≥ 4) were 61% and 71%. This is different from the results of Bang, Edwards, Bomback, Ballantyne, Brillon, Callahan, Teutsch, Mushlin, and Kern research which found that the sensitivity and specificity of the ADA scoring method (with a score of ≥ 4) is 76% and 54%[16]. Besides, in the study of Poltavsky, et al., It was also found that the sensitivity and specificity of the ADA scoring method for the ADA scoring method (with a score ≥ 4) were 73% and 57%[13]. Differences in sensitivity and specificity values are possible due to differences in the demographic characteristics of the study subjects including the mean BMI (25.6 kg/m2: 28.2 kg/ m2: 28.3 kg/m2) and the proportion of sex (1:4 and 1:1 and 1:1) which results in low sensitivity and specificity of ADA scoring in the study population. WHO Expert Consultations concluded that the cut off of BMI at risk of diabetes and heart disease in Asian populations is lower than the cut-off of WHO overweight (25 kg/m2)[17]. Correspondingly, Hsia, Larrivee, Cefalu, and Johnson recommend that the IMT cut-off for prediabetes screening be lower (≥23kg/m2: ≥25 kg/m2) in Asian populations and increase the sensitivity of prediabetes screening in populations aged ≥ 45 years[18]. This is due to

the high percentage of body fat and abdominal circumference in Asian populations compared to European populations[19]. Therefore, some item points from the ADA scoring system were modified i.e. the point values of the sex items were exchanged and the IMT classification was based on the WHO obesity criteria for the Asia Pacific population, the sensitivity value of the scoring method was higher, from 61% to 81% but the specificity value dropped from 71% to 63%.

Based on the 2x2 table analysis results, the positive predictive value, and negative predictive value of this scoring method is 21% and 94%. This is different from the results of research by Bang, et al., found that the positive predictive value and negative predictive value of the ADA scoring method is 50% and 78%[16]. Correspondingly, in the study of Poltavsky, et al., It was found that the positive predictive value and the negative predictive value of the ADA scoring method were 53% and 77%[13]. This difference is possible due to differences in some of the demographic characteristics of the subjects including the proportion of sex and the mean and the proportion of BMI. In this study the proportion of male sex is not balanced which is 1:4 (81.4%:18.6%) different from the

study of Bang, et al., and Poltavsky, et al., which is 1:1[16,13]. As a screening tool, a fairly low sensitivity value (61%) makes this scoring method an opportunity to be modified and simulated by changing points based on the respondent's context or characteristics. After some of the items scoring points have been modified, namely gender point value and BMI classification, the positive predictive value remains the same but the negative predictive value is higher ie from 94% to 96%. As for the accuracy value of the ADA scoring method based on the research of Bang, et al., and Poltavsky, et al., namely 73% and 79%[16,13]. In this study, the accuracy or accuracy of the ADA scoring method is 69.8%. After the points and items of gender and obesity criteria were modified to drop to 64.8%. The limitation of this study is that the proportion of sexes that is not balanced has an impact on the inference of the results of research in other populations. But this can be reduced by the analysis of gender adjustment. No other factor was measured as a question item in the scoring method questionnaire such as central obesity, smoking status, and cholesterol levels[20,21,3]. The strength of this study is that the ADA scoring method was found with the modification that is sensitive and quite specific in screening patients with prediabetes and can be used in primary health facilities.

CONCLUSIONS

The ADA scoring method cannot be used directly at primary level health facilities. The sensitivity and specificity of the ADA scoring method are 61% and 71%. The ADA scoring method with relative modification can be used at primary level health facilities. After some points of the item scoring are modified, the sensitivity and specificity of the scoring method become 81% and 63%.

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Ethical Approval and Informed Consent

This research has been approved by the Medical and Health Research Ethics Committee (MHREC) from the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada with reference number KE/FK/0672/EC/2017.

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Availability of Data and Material

Data and material can be accessed via the corresponding author.

Conflict of Interest

None.

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