Open Access Original Research

The 4th International Conference on Applied Science and Health (ICASH 2019), 23-24 July 2019, Faculty of Graduate Studies, Mahidol University, Thailand

Determinants of Pre-Diabetes on Teenagers in Palangka Raya City

Ester Inung Sylvia*, Gad Datak, Visia Didin Ardiyani

Health Polytechnic of Palangka Raya (Poltekkes Palangka Raya), Indonesia
***Corresponding author's email:** esterinung@yahoo.co.id

ABSTRACT
Background: Pre-diabetes is a stage prior to diabetes mellitus (DM) and many studies in west countries found the risk factors of diabetes were mostly related to the nutritional status of being overweight and obese. Diabetes mellitus is not only experienced by adults but also by teenagers. They have the potential for pre-diabetes because they may have unhealthy lifestyles such as smoking, consuming alcohol, high-calories, and junk foods and lack of physical activity. This study aims to determine the risk factors of pre-diabetes among senior high school students in Palangka Raya, Central Kalimantan, Indonesia.
Methods: This study was a qualitative study using a questionnaire as an instrument for data collection. It consists of a set of questions on diabetes risk. This research conducted in four public senior high schools in Palangka Raya with the total sample was 131 respondents have participated in this research.
Results: 25 respondents (19.1%) from a total sample of 131 participants suffered from pre-diabetes and 30.5% of respondents had a family with DM. Some students (6.9%) had a smoking habit and 13% incidence of pre-diabetes in high school students related to these factors (R2: 0.13). Only less than half of the total respondents (43.5%) had a normal BMI. As many as 39.7% of respondents were undernourished while the rest were overweight.
Conclusion: Pre-diabetes factors on teenagers in Palangka Raya are female dominate had a history of DM, and being overweight. This study further leads to the importance of weight control that focusing on physical activity and dietary management as early precautions. Health education is required to suppress the number of risk factors for diabetes.
Keywords: Pre-diabetes, Palangka Raya High School Students, Indonesia
Received: 14 May 2019 **Reviewed:** 29 May 2019 **Revised:** 16 June 2019 **Accepted:** 6 July 2019
DOI: 10.35898/ghmj-33455

Selection and peer-review under responsibility of the scientific committee and the editorial board of The 4th International Conference on Applied Science and Health (ICASH 2019)

1. Introduction

Urbanization and modernization have succesfully changed community's lifestyles. This leads to shifting disease pattern from communicable to noncommunicable diseases. For example, in recent years, diabetes mellitus (DM) is known as one of the most chronic diseases in the world. According to Indonesia's National Basic Health Research (2013), 6.9% of Indonesian population suffered from diabetes (Kemenkes, 2013). Interestingly, diabetes mellitus is not only experienced by adults but also teenagers. According to Indonesian Peaditrician Association (IDAI), the incidence of diabetes in children aged 0- 18 years will be increased 7 times in 10 years (Kemenkes, 2018).

Driven by economic development, nutrition transition, and increasingly sedentary lifestyles, the prevelence of diabetes were mostly started in young aged (Chan et al., 2009). Smoking, alcohol, consuming high-fat and calories meals as well as lack of physical activity contribute to the incidence of DM in teenagers (Kemenkes, 2018; Chan et al., 2009). Moreover, many studies in west countries found the risk factors of diabetes were mostly related to nutritional status of being overweight and obese (Chan et al., 2009; Spurr et al., 2017). Unfortunately, there are still limited studies related to prediabetes risk factors in high school students, especially in Indonesia, which has a wide range of teenagers' characteristics. A preliminary study needs to be done, taking an example of Palangka Raya, the most lively city in Central Kalimantan, Indonesia, in which the prevalence of diabetes exceeded the national average (>0.7%). Therefore, this study aims to identify prediabetes risk factors among high school students in Palangka Raya. This study is important to prevent further development towards diabetes through management at prediabetes stage.

2. Method

2.1 Respondents

Respondents were recruited using multistage random sampling from four public senior high schools in Palangkaraya. Minimum sample size (n=131) was calculated based on Lameshow formula and considering the proportion of students Lemeshow et al. (1990). Eligible respondents were students aged 14-19 years old, male (n=53) or female (n=78) students. Individuals who were sick during the survey were excluded. There were no drop outs in this study. Written inform consent was obtained from participants prior to survey.

2.2 Measurements

This survey employed a questionnaire as an instrument for data collection. It consists of a set of questions on diabetes risk related items such as smoking, Body Mass Index (BMI), physical activity (more than 30 minutes any physical activity at a time in a week), and also family history of diabetes. Anthropometric measurements including height and weight were also taken to complete BMI calculation. BMI was calculated by using following formula: BMI = weight (kg) divided by height (m2). Blood glucose measurement was carried out at Prodia Laboratory, Palangka Raya. The measurements were performed twice. First, the blood sample was taken after the respondents were fasting for 8-10 hours. After that, respondents consumed glucose water (as much as 75 grams of sugar were dissolved into 300 ml of water). The second blood sample was taken 2 hours after the consumption of concentrated glucose solution. Respondents were diagnosed as prediabetes when their fasting plasma glucose level ranged at 100-125 mg/dl or once their oral glucose tolerance test ranged at 140-199 mg/dL.

2.3 Data Analysis

Descriptive data analysis was used to describe respondents' risk factors, including age, gender, BMI, physical activity, smoking and family history of diabetes. Chi Square test was conducted to determine the relationships of risk factors (independent variable) and the incidence of prediabetes (dependent variable). Odds ratio was calculated to measure the strength of the association between both variables. Logistic Regression was also conducted to study the effect of the incidence of prediabetes on glucose level, diet, physical activity, obesity, age and gender.

3. Results

Table 1 shows 25 respondents (19.1%) from total sample of 131 students suffered from prediabetes and 30.5% respondents had family with DM. Some students (6.9%) had smoking habit and most of respondents (69.5%) had physical activity of less than 3 times a week. Only less than half of total

respondents (43.5%) had a normal BMI. As many as 39.7% respondents were undernourished while the rest were overweight.

Table 1. Overview of Respondents' Characteristics (n=131)

Variable	n	%
Non prediabetes	106	80.9
Prediabetes	25	19.1
History of DM		
Yes	40	30.5
No	91	69.5
Smoking		
Yes	9	6.9
No	122	93.1
Physical Activity		
< 3 times	91	69.5
$\geq$ 3 times	40	30.5
BMI		
Normal	57	43.5
Underweight	52	39.7
Overweight	22	16.8

In details, according to Table 2, prediabetes students were mostly female (25.6%). The amount of risk obtained from gender is 3.3 (95% CI: 1.2-9.5), meaning that female students are more at risk of prediabetes by 3.3 times compared to male students. This was confirmed by Chi square test, which shows a signifancy value at gender variable ($p < 0.05$).

Table 2. Bivariate Analysis of Prediabetes Risk Factors (n=131)

Variables	Non Prediabetes		Prediabetes		Total		OR 95% CI	p value
	N	%	N	%	N	%		
Gender								
Male	48	90.6	5	9.4	53	100	3.3 (1.2-9.5)	0.021*
Female	58	74.4	20	25.6	78	100		
History of DM								
No	77	84.6	14	15.4	91	100	2.1 (0.9-5.1)	0.104
Yes	29	72.5	11	27.5	40	100		
Smoking habit								
Yes	8	88.9	1	11.1	9	100	1.9 (0.2-16.4)	1.000
No	98	80.3	24	19.7	122	100		
Physical activity								
$\geq$ 3 times	35	87.5	5	12.5	40	100	1.9 (0.7-5.9)	0.204
< 3 times	71	71	20	22.0	91	100		
BMI								
Normal	47	82.5	10	17.5	57	100	1	-

Underweight	44	84.6	8	15.4	52	100	0.9 (0.3-2.4)	0.762
Overweight	15	68.2	7	31.8	22	100	2.2 (0.7-6.8)	0.172

*significant at the p value 0.05

Almost half of prediabetes students (44%) had a history of diabetes in their family. On the other hand, there were 27.3% respondents of nonprediabetes students had family with DM. OR value shows that students with a family history of DM are 2.1 times more vulnerable suffered from prediabetes (95% CI: 0.9-5.1). Students with smoking habits also shown differences in proportions. Students who do not smoke are more likely to experience prediabetes (19.7%) than those who smoke (11.1%). This risk difference is 1.9 times (95% CI: 0.2-16.4), meaning that non-smokers have a higher risk of having 9 prediabetes compared to non-smokers. However, this risk is not proven significantly based on statistical tests (p>0.05).

Students with physical activity < 3 times a week, tend to experience prediabetes (22.0%) compared to students who do physical activity ≥ 3 times (12.5%). This risk difference is 1.9 times (95% CI: 0.7-5.9), meaning that students who do physical activity < 3 times a week are 1.9 times in risk of prediabetes than students who do physical activity ≥ 3 times in a week. But this risk is not proven statistically (P>0.05).

BMI variables are made of dummy variables with normal BMI as a reference group. Students who were thinner BMIs were not at risk of having TGT levels of 0.9 times compared to students with a normal BMI (95% CI: 0.3-2.4). Meanwhile, students whose BMI were overweight at risk of prediabetes 2.2 times compared to students with a normal BMI (95% CI: 0.7-6.8). However, it was not proven statistically (p>0.05).

Based on the results of bivariate analysis there were 4 variables with p values <0.25, namely gender, history of diabetes, physical activity, and BMI. The four variables were input into multivariate modeling using multiple logistic regression tests. The P values of four the variables that enter into the model were checked. If the value of P> 0.05, the variable were excluded from the model. After the variable were excluded, then the OR value changes were examined to assess whether the variable is in the form of confounding of other variables or not. If the change in the value of OR>10% then the variable is confounding. The excluded variable starts with the variable that had the largest P value.

Table 3. (not fixed)Relationship between Gender, History of DM, Physical Activity, and BMI with the incidence of Prediabetes, in public high school Palangkaraya (n=131)

Variables	Model 1	Model 2	Model 3
	OR	OR	OR
	95% CI	95% CI	95% CI
Sex			
Female	3.4	3.1	3.7
Male	(1.1-10.5)	(1.0-9.5)	(1.2-11.2)
History of DM			
No	2.2	1.5	2.2
Yes	(0.9-5.8)	(0.5-4.6)	(0.9-5.6)
Physical Activity			
< 3 times	1.5	2.3	-
$\geq$ 3 times	(0.5-4.7)	(0.9-5.8)	-
BMI			
Normal	1	-	

Underweight	1.2 (0.4-3.5)		
Overweight	2.5 (0.8-8.2)		
N	131	131	131
R^2	0.135	0.108	0.130
-2 loglikelihood	116.2015	118.577	116.654

Table 3 shows the results of logistic regression hypothesis test. When the BMI variable was tried to be excluded there was a change in OR values reaching >10%. Therefore, variables with changes in OR values>10% are re-entered into the regression equation. The physical activity frequency variable is excluded from the equation and the OR value does not change>10% , this variable is excluded from the regression equation. So, the final result of the multiple logistic regression test states that gender variables, history of DM, and BMI affect the occurrence of prediabetes in students in all four public high school in the City of Palangkaraya. The obtained value in model 2 is 0.130, which means that these variables can explain the incidence of prediabetes in high school students by 13%.

4. Discussion

The prevalence of prediabetes in the four Public High School in Palangkaraya City mostly occurs in female students compared to men, namely 9.4%. When viewed from gender, women are more likely to have diabetes than men. This is not certain yet, but if it is associated with BMI, women have the risk having a greater BMI than men. As the results of a study conducted by Casapulla which showed that there was a significant relationship to BMI and gender where women had a higher BMI than men (Casapulla et al., 2017). In addition, the monthly cycle syndrome and post-menopause make the distribution of body fat easily accumulated. But this is different from the results of the Spurr study which showed no significant difference between men and women diagnosed with prediabetes, with a difference of 2% from the percentage mostly in men. Previous research also mentions that teenage girls who are experience prediabetes are more obese than men with prediabetes (Spurr et al., 2017).

Genetic factors are important factors in diabetes. Abnormalities that transferred to their heir can directly affect beta cells and change their ability to recognize and spread insulin secretion stimuli. Siperstein in Waspadji stated in his study of diabetic patients it was found that 90% had abnormalities in the basal membrane of the muscle and similar abnormalities were found in 53% of non-diabetics whose parents had diabetes (Spurr et al., 2017). The risk of prediabetes increases more in individuals who have a family history of diabetes than those without a history of diabetes (Waspadji, 2009). The same thing was found in this study when viewed from a family history of diabetes there was a difference in the proportion of TGT levels between students who had a family history of diabetes and those who did not. The majority of prediabetes students had a history of diabetes in the family (27.5%) compared to those without a history of diabetes (15.4%). Meanwhile, there were more students who did not have prediabetes also had no history of diabetes in the family (84.6%) compared to those who had a history of diabetes (72.5%). This is in line with previous studies that showed that a history of diabetes in the family is a major risk factor that causes abnormal blood sugar levels, which in turn causes the status of prediabetes. The prevalence of abnormal blood sugar levels is 1.9 times more likely in adolescents who have a family history of diabetes (Al Amiri et al., 2015).

Smoking habits are not a direct cause for an increase in blood sugar, but smoking and diabetes mellitus are a dangerous combination. Cigarettes can increase the risk of diabetes. Statements from previous studies show that respondents who used to and are still smoking both have a higher risk of developing diabetes, where smokers tend to have less physical activity and consumption of vegetables (Spijkerman et al., 2014). This can also be seen from studies where more non-smoking students were seen to have more than normal levels of TGT (19.7%) compared to those who smoked (11.1%). This

risk difference is 1.9 times (95%CI: 0.2- 16.4), meaning that students who don't smoke are more at risk of prediabetes compared to non-smokers. However, it was not proven significantly based on statistical tests (P>0.05).

Variables of physical activity carried out by students in four public high school in Palangkaraya were mostly done only <3 times a week. The results showed that the risk of prediabetes was greater for students who did physical activity <3 times a week. According to Soewondo and Pramono (2011), physical activity has less intermediate to strong correlation with the condition of prediabetes. According to the researchers' assumptions, physical activity is very useful for the use of glucose in one's blood. Individuals who lack activity tend to have obesity body proportions. Obesity conditions will trigger an increase in insulin resistance in the muscles so that blood glucose cannot be used optimally by muscles as energy. This is in line with the results of Puji's research which states that physical activity can trigger the regulation and control of glucose levels in the blood So the researchers' assumption that physical activity carried out <3 times a week can lead to prediabetes, which is characterized by increased levels of glucose in the blood (Puji et al., 2017) as previously found that the risk of developing prediabetes will increase in adolescents who have sedentary activity and risk will decrease for those whose activities are medium and heavy (Pandey et al., 2017). Studies show that someone who is over 20% has a greater risk of developing diabetes mellitus, hypertension, coronary heart disease, stroke, arthritis, and cancer (Cuasay et al., 2001).

In this study showed that respondents with overweight BMI at risk of prediabetes were 2.2 times compared to students with normal BMI (95% CI: 0.7-6.8). In line with the research of Adnan et al. (2013) that stated BMI has a relationship with blood sugar in diabetics. According to researchers increased BMI above normal can increase muscle insulin resistance which results in impaired use of blood glucose by muscles so that glucose in the blood becomes above normal. If this happens long enough and supported by other diabetes risk factors it will trigger the condition of prediabetes. The same case with Widodo's research, the result showed a relationship between BMI and the risk of developing diabetes in high school adolescents (Widodo et al., 2017). This event can continue to diabetes if the trigger factors for diabetes are not handled properly. Previous research stated that there was a significant relationship between BMI and adolescent prediabetes. The possibility is that every 1 kg / m^2 exposure to BMI has an increase of 1,067 times the risk of prediabetes (Pandey et al., 2017). One of them is BMI can be overcome by doing good physical activities such as exercise. During exercise glucose will be used as energy. Physical activity is carried out 3 times a week with duration of 30-60 minutes each time can reduce these risk factors.

This study further lead to the importance of an early precaution of preventing diabetes to all the students especially the one who had prediabetes by adding additional physical activities outside the obligatory physical education like extracurricular and to improve school health unit by collaborating with Social Insurance Administration Organization for prediabetes screening. Also dietary management is also needed and doing physical activity or exercise minimum 3 times in a week with duration of 30-60 minutes. These behaviors can control the weight to maintain it in a normal range.

5. Conclusion

High school students in Palangkaraya who are female, have a family history of DM, lack of physical activity, BMI in the category of overweight are more at risk of prediabetes. This study further leads to the importance of weight control that focusing on physical activity and dietary arrangements as early precautions. Future research about health education to prevent diabetes is needed to suppress the number of risk factors of diabetes.

Conflict of Interest

There is no conflict of interest.

REFERENCES

Adnan, Mulyati, T., and Isworo, J. (2013). Relationship between body mass index (bmi) and blood glucose levels in patients with t2dm in the outpatient room of tugurejo hospital semarang.

Al Amiri, E., Abdullatif, M., Abdulle, A., Al Bitar, N., Afandi, E. Z., Parish, M., and Darwiche, G. (2015). The prevalence, risk factors, and screening measure for prediabetes and diabetes among emirati overweight/obese children and adolescents. *BMC Public Health*, 15(1):1298.

Casapulla, S. L., Howe, C. A., Mora, G. R., Berryman, D., Grijalva, M. J., Rojas, E. W., Nakazawa, M., and Shubrook, J. H. (2017). Cardiometabolic risk factors, metabolic syndrome and pre-diabetes in adolescents in the sierra region of ecuador. *Diabetology & metabolic syndrome*, 9(1):24.

Chan, J. C., Malik, V., Jia, W., Kadowaki, T., Yajnik, C. S., Yoon, K.-H., and Hu, F. B. (2009). Diabetes in asia: epidemiology, risk factors, and pathophysiology. *Jama*, 301(20):2129–2140.

Cuasay, L. C., Lee, E. S., Orlander, P. P., Steffen-Batey, L., and Hanis, C. L. (2001). Prevalence and determinants of type 2 diabetes among filipino-americans in the houston, texas metropolitan statistical area. *Diabetes Care*, 24(12):2054–2058.

Kemenkes (2013). riskesdas.

Kemenkes (2018). Hati-hati, anak pun bisa diabetes (be careful, children can get diabetes). http://www.depkes.go.id/article/view/18110100002/hati-hati-anak-pun-bisa-diabetes.html. (Accessed on 1 November 2018).

Lemeshow, S., Hosmer, D. W., Klar, J., Lwanga, S. K., Organization, W. H., et al. (1990). *Adequacy of sample size in health studies*. Wiley, Chichester.

Pandey, U., Midha, T., Rao, Y. K., Katiyar, P., Wal, P., Kaur, S., and Martolia, D. S. (2017). Anthropometric indicators as predictor of pre-diabetes in indian adolescents. *Indian heart journal*, 69(4):474–479.

Puji, Heru, and Agus, S. (2017). Aerobic exercise for reducing blood glucose levels in patients with t2dm in the bukateja purbalingga health center area. *Media Ners Journal*, 1(2):49–99.

Soewondo, P. and Pramono, L. A. (2011). Prevalence, characteristics, and predictors of pre-diabetes in indonesia. *Medical Journal of Indonesia*, 20(4):283–94.

Spijkerman, A. M., Nilsson, P. M., Ardanaz, E., Gavrila, D., Agudo, A., Arriola, L., Balkau, B., Beulens, J. W., Boeing, H., de Lauzon-Guillain, B., et al. (2014). Smoking and long-term risk of type 2 diabetes: the epic-interact study in european populations. *Diabetes care*, 37(12):3164–3171.

Spurr, S., Bally, J., Bullin, C., and Trinder, K. (2017). Type 2 diabetes in canadian aboriginal adolescents: risk factors and prevalence. *Journal of pediatric nursing*, 36:111–117.

Waspadji, S. (2009). *Diabetes Melitus: Basic Mechanism and Rational Management (Management of Integrated Diabetes Mellitus)*. Faculty of Medicine, University of Indonesia, Jakarta.

Widodo, D., Retnaningtyas, E., and Fajar, I. (2017). The risk factors of diabetes mellitus in adolescent senior high school in malang city. *Jurnal Ners*, 7(1):37–46.

Cite this article as: Sylvia EI, Datak G, Ardiyani VD. Determinants of Pre-Diabetes on Teenagers in Palangka Raya City. GHMJ (Global Health Management Journal). 2019; 3(3):117-123. doi:10.35898/ghmj-33455