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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Association Between Nutrition Knowledge and Nutritional Status with Blood Glucose Status in Rural Areas

Andi Eka Yunianto, Ali Khomsan, Cesilia Meti Dwiriani and Naufal Muharam Nurdin
Department of Community Nutrition, Faculty of Human Ecology,
Bogor Agricultural University, Bogor-16680, Indonesia

Abstract: The objectives of this study were to: analyze the association between nutrition knowledge and nutritional status with blood glucose status in rural areas. The design of this study was cross-sectional and this study was conducted on 84 people aged 45-59 years from 42 households in Cisalak Village, Cibeber Sub-district, Cianjur District. The result showed that there was no significant difference in the blood glucose status between rural men and women. All participants had low nutrition knowledge. The nutritional status were normal in men and women. Waist circumference (OR = 3.280; 95% CI: 1.093-9.843) and visceral fat (OR = 2.882; 95% CI: 0.983-8.455) were significantly related to blood glucose status. This implied that nutrition education on the importance of maintaining a normal weight needed to be done to avoid the risks and complications due to high blood sugar status. Socialization to general public was also needed, particularly about the importance of maintaining body weight by adopting healthy lifestyle such as not smoking, regular exercise and lessening the consumption of sweet food or sugar-sweetened beverages, in order to maintain blood glucose status.

Key words: Nutrition knowledge, glucose status, nutritional status

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disorder determined by the degree of hyperglycemia (elevated fasting blood glucose level) and can lead to the risk of microvascular damage (retinopathy, nephropathy and neuropathy). It is associated with decreased life expectancy, increased incidence of diabetes with microvascular complications, increased risk of macrovascular complications (ischemic heart disease, stroke and peripheral vascular disease) and decreased quality of life (WHO, 2006).

The global prevalence of diabetes among adults aged 20-79 years in 2010 was 6.4% (285 million adults) and was estimated to be 7.7% (439 million adults) in 2030. Between 2010 and 2030, there will be a 69% increase in the number of adults with diabetes in developing countries and an increase by 20% in developed countries (Shaw *et al*., 2009). In 2013, International Diabetes Federation (IDF) stated that Indonesia ranked 7th in terms of DM prevalence (8.5%) in the world.

The Ministry of Health (MoH) stated that diabetes prevalence for people aged = 15 years in Indonesia increased, from 5.7% in 2008 to 6.9% in 2014. The prevalence of this disease in rural areas was also experiencing a significant increase, from 4.4% in 2008 to 7.0% in 2014. Diabetes prevalence in West Java also showed a significant increase, from 1.3% in 2008 to 2.0% in 2014.

Previous study conducted in seven villages (Sangit, Pedawa, Penglipuran, Tenganan, Ubud, Legian and Ceningan) in Bali Province showed that the total prevalence of diabetes in middle age was 27.4% (Suastika *et al*., 2011). O'Connor and Wellenius (2012) stated that the older people were, the more susceptible they were to DM, which started between the ages of 35 and over 65. Middle-aged people were 8.9 times at higher risk of having diabetes than adults.

Public knowledge is the basis to determine the lifestyle and behavior in a community. Therefore, it is the key determinant to distinguish people who are at risk from those who are free of diabetes risk (Lorga *et al*., 2012). The risk of diabetes between the ages of 40 and 59 was significantly influenced by overweight and obesity (Wannamethee *et al*., 2004). Proper nutrition should be managed to prevent overnutrition (Grylls *et al*., 2003). Zhang *et al*. (2014) stated that there was a strong association between obesity and blood glucose status. Overweight can be a mean to increase glycemic control of adults with diabetes.

Based on the above description, it is important to identify the individual with DM in order to determine public knowledge regarding diabetes, particularly the fact that middle-aged people are highly vulnerable to the onset of DM. Therefore, the aim of this study was to identify the knowledge, lifestyle and nutritional status and their association with blood glucose status in rural men and women.

General objective of this study was to analyze the nutrition knowledge of rural community and its association with blood glucose status in rural men and

Corresponding Author: Andi Eka Yunianto, Department of Community Nutrition, Faculty of Human Ecology, Bogor Agricultural University, Bogor-16680, Indonesia

women. Meanwhile, the specific objectives of this study were to identify the sociodemographic characteristics, analyze the difference in blood glucose status between rural men and women, analyze the nutrition knowledge and nutritional status of rural men and women and analyze the association between nutritional status and blood glucose status.

MATERIALS AND METHODS

The design of this study was cross-sectional. The study was conducted in Cisalak Village, Cibeber Sub-district, Cianjur District. The selected village was Cisalak Village with the consideration that the village was predominantly rural areas and had large agricultural areas based on the results of a survey by the district authority. Participants of this study were randomly selected from the population of middle-aged people, with the following inclusion criteria: a married couple aged 45-59 years, can speak well and were willing to participate in the study by signing the informed consent. Number of participants required was 84 people from 42 households consisting of husband and wife.

Sociodemographic characteristics: Data of sociodemographic characteristics (age, duration of study, occupation, income and expenditure per capita/month) were collected through direct interview using a questionnaire.

Nutrition knowledge: Data of nutrition knowledge were collected through direct interview at respondents. Questionnaire about nutrition knowledge was drawn from the study by Lorga *et al*. (2012) and then validated and redeveloped by the researchers. Questions about nutrition knowledge consisted of 10 questions, namely general knowledge, knowledge about risk factors, knowledge about the disease and its complications, as well as knowledge of high-risk food. The correct answer would be given score "1" and the wrong answer will be given "0" (zero) score. Then the score was categorized as good (>80%), moderate (60-80%) and low (<60%) (Khomsan, 2000).

Fasting blood glucose: Fasting blood glucose measurement was preceded by an overnight fasting for 8-12 h before the blood samples were collected. Venous blood samples were collected by medical personnel. After that, the samples were analyzed using hexokinase method by an accredited laboratory. A participant was categorized as pre-diabetes if the blood glucose level was $\geq$100 mg/dl and diabetes if the level was $\geq$126 mg/dl (IDF, 2013).

Body mass index: Body weight was measured using a digital scale with a capacity of 200 and 0.1 kg accuracy. Height was measured using microtoise with a capacity of 200 and 0.1 cm accuracy. Body mass index (BMI) was calculated using the ratio of body weight (kg) by the square of height (m^2). Obese was defined as BMI $\geq$25 kg/m^2 (Perkeni, 2011).

Waist circumference: Waist circumference (WC) was measured using a measuring tape with 0.1 cm accuracy. It was measured by wrapping the tape to the navel as the main boundary. A participant was categorized as obese if WC $\geq$90 cm for men and $\geq$80 cm in women (Perkeni, 2011).

Body fat percentage and visceral fat: Body fat percentage (BFP) and visceral fat were measured by Bioelectrical Impedance Analysis (BIA). Participants were categorized as obese if their BFP were $\geq$24% in men and $\geq$35% in women for 40-59 age group (Gallagher *et al*., 2000). Obese was also defined as visceral fat $\geq$10 for men and women (Unno *et al*., 2012).

Statistical analysis: The data were processed and analyzed by descriptive and inferential statistics using 2013 Microsoft Excel and SPSS version 16.0 for Windows. Comparative test used in this study was Mann-Whitney test for analyzing blood glucose status in rural men and women with significance level (p) <0.05. Correlation test used in this study was chi-square test for analyzing the association between nutritional status and blood glucose status with $p<0.05$.

RESULTS

Cibeber Sub-district is one of sub-districts which produces agricultural product, especially rice. It also becomes the mainstay of agricultural producers in Cianjur District. Total area of Cibeber Sub-district is 130.96 km^2 with 117,651 people. The selected village in this study was Cisalak Village with consideration that the village predominantly rural areas and had extensive agricultural areas based on the result of a survey by the district authority.

Based on age, more than half of men (52.4%) were $\geq$54 years and most of the women aged less than 54 years. Education level in this study, either in men or women, in general were quite low. Most of rural men and women worked as farm workers. The rest of them worked as farmers, construction workers, merchants, civil servants/ private employee, housewives and other jobs (car driver, temporary employee, workers in village unit cooperatives/Koperasi Unit Desa, motorcycle taxi driver and caregivers). Distribution of sociodemographic characteristics are shown in Table 1.

Mean household income per capita per month of the participants was Rp 957,031 while the mean household expenditure per capita per month was Rp 966,777. Based on these results, there was an imbalance between household income and expenditure. Most of the

Table 1: Sociodemographic characteristics of the participants

	Men		Women		Total	
Sociodemographic characteristics	n	%	n	%	n	%
Age (years)						
<54	20	47.6	36	85.7	56	66.7
≥54	22	52.4	6	14.3	28	33.3
Mean±SD	53.6±3.6	53.6±3.6	49.3±3.3	49.3±3.3	51.4±4.1	51.4±4.1
Duration of study (years)						
≤6	33	78.6	36	85.7	69	82.1
>6	9	21.4	6	14.3	15	17.9
Mean±SD	6.4±3.4	6.4±3.4	6.3±2.4	6.3±2.4	6.3±2.9	6.3±2.9
Occupation						
Farmer	3	7.1	2	4.8	5	6.0
Farm worker	22	52.4	13	31.0	35	41.7
Construction worker	3	7.1	0	0	3	3.6
Merchant	4	9.5	7	16.7	11	13.1
Civil servant/private employee	3	7.1	1	2.4	4	4.8
Housewife	0	0	18	42.9	19	21.4
Others	8	19.1	1	2.4	8	9.5

Abbreviation: SD: Standard deviation

Table 2: Distribution of participants based on blood glucose status

	Pre-diabetes/Diabetes		Non-diabetes		
Diabetes status	n	%	n	%	p-value*
Men	8	44.4	34	51.5	0.597
Median (min; max)	156.0 (101;442)	156.0 (101;442)	88.5(77;99)	88.5(77;99)	
Women	10	55.6	32	48.5	
Median (min; max)	112.5 (103;374)	112.5 (103;374)	90.5(79;99)	90.5(79;99)	
Total	18	100	66	100	
Median (min; max)	115.5 (101;442)	115.5 (101;442)	89.0(77;99)	89.0(77;99)	

*Mann-Whitney test, significant at α <5%

household expenditures (59.4%) were used for non-food expenditures. Mean of non-food expenditures was Rp 574,274/month and the SD was Rp 499,464. Meanwhile, more than a third of total expenditure (40.6%) were used for food expenditures. Mean of food expenditures was Rp 392,503/month and the SD was Rp 940,003. Non-food expenditures observed in this study were health care, cigarettes, sanitation, fuel, children's education, clothing, mobile phone's bill and installment (credit or social gathering). Food expenditures were in the form of spending on staple foods, side dishes, vegetables, fruits and snacks.

Total participants who had high blood glucose status were 18 people, consisting of 8 men and 10 women. Blood glucose status (pre-diabetes/diabetes) in men was higher than women. Median blood glucose in men and women in pre-diabetes/diabetes group respectively was 156 (101; 442) mg/dl and 112.5 (103; 374) mg/dl. Total participants with normal blood glucose status were 66 people, consisting of 34 men and 32 women. Median blood glucose in non-diabetic men was 88.5 (77; 99) mg/dl and in non-diabetic women was 90.5 (79; 99) mg/dl. Median blood glucose of the participants in pre-diabetes/diabetes group was 115.5 (101; 442) mg/dl and in non-diabetes group was 89.0 (77; 99) mg/dl. These results can be seen in Table 2.

Men's mean BMI was categorized as normal (21.7 kg/m^2) while women's mean BMI was categorized as overweight (25.1 kg/m^2). Based on visceral fat, men and women in this study had normal nutritional status with mean visceral fat for men was 7.5 and mean for women was 8.3. Based on mean WC of the participants, men generally had normal nutritional status (mean WC = 79.5 cm) while women in general were overweight (mean WC = 88.2 cm). Based on participants' mean BFP, rural men and women had normal nutritional status in which mean BFP for men was 19.7% and mean BFP for women was 33.7%. Distribution of nutritional status of rural men and women can be seen in Table 3.

The overall response rate was 100% for all questions in men and women. We assessed the diabetes knowledge briefly in 4 parts (1) general knowledge, (2) knowledge about risk factors, (3) knowledge about the desease and its complications, (4) knowledge of high-risk foods. General knowledge of diabetes was assessed by one question. One-third of the participants (men and women) answered correctly (40.5-42.9%).

The knowledge about the risk factors was assessed by two questions. More than one-third of participants answered correctly (35.7-42.9%). More than one-third of the men (40.5%) and women (38.1%) knew that overweight people tended to have diabetes. More than one-third men (35.7%) dan women (42.9%) knew that regular exercise could lessen the risk of diabetes.

The knowledge about the disease and its complications was assessed by four question. A few men (16.7%) and women (19.0%) knew that frequent numbness in hands and feet was a symptom of diabetes. Less than 30%

Table 3: Distribution of participants based on the nutritional status

	Men		Women	
Nutritional status	n	%	n	%
Body mass index (kg/m^2)				
Underweight (BMI<18.5)	2	4.8	1	2.4
Normal (18.5≤BMI<25.0)	33	78.6	23	54.8
Overweight (25.0≤BMI<27.0)	4	9.5	7	16.7
Obese (BMI≥27.0)	3	7.1	11	26.2
Mean±SD	21.7±3.1	21.7±3.1	25.1±4.6	25.1±4.6
Visceral fat				
<10	30	71.4	28	66.7
≥10	12	28.6	14	33.3
Mean±SD	7.5±4.1	7.5±4.1	8.3±4.9	8.3±4.9
Waist circumference (cm)				
Normal (Men: <90 cm; Women: <80 cm)	34	81.0	13	31.0
Overweight (Men: ≥90 cm; Women: ≥80 cm)	8	19.0	29	69.0
Mean±SD	79.5±9.9	79.5±9.9	88.2±13.8	88.2±13.8
Body fat percentage (%)				
Mild (Men: <8%; Women<21%)	1	2.4	0	0
Moderate (Men: 8%≤BFP<24; Women: 21%≤BFP<35%)	29	69.0	22	52.4
Obese (Men: ≥24%; Women: ≥35%)	12	28.6	20	47.6
Mean±SD	19.7±6.9	19.7±6.9	33.7±5.2	33.7±5.2

Table 4: Distribution of participants based on the correct answers for each question of nutrition knowledge

	Nutrition knowledge					
	Men		Women		Total	
Questions	n	%	n	%	n	%
General knowledge						
Diabetes is a communicable disease	18	42.9	17	40.5	35	41.7
Knowledge about the risk factors						
Overweight people tend to have diabetes	17	40.5	16	38.1	33	39.3
Regular exercise can lessen the risk of diabetes	15	35.7	18	42.9	33	39.3
Knowledge about the disease and its complications						
Frequent numbness in hands and feet is a symptom of diabetes	7	16.7	8	19.0	15	17.9
Diabetic people have to take care of their feet well	12	28.6	11	26.2	23	27.4
Untreated diabetes can lead to blindness	13	31.0	13	31.0	26	31.0
Wounds in diabetic patients are slow to heal	21	50.0	21	50.0	42	50.0
Knowledge of high-risk foods						
Diabetic patients should eat less rice	21	50.0	21	50.0	42	50.0
Diabetic patients should lessen the consumption of fatty foods such as beef tallow, offal and brain	18	42.9	16	38.1	34	40.5
Diabetic patients are strongly encouraged to eat tempeh	13	31.0	14	33.3	27	32.1

participants knew that diabetic people had to take care of their feet well. More than 30% participants knew that untreated diabetes could lead to blindness. Half of participants knew that wounds in diabetic patients were slow to heal.

Regarding the high-risk foods, half of the participants knew that diabetic patients should eat less rice. More than one-third of the men (42.9%) and women (38.1%) knew that diabetic patients should lessen the consumption of fatty food such as beef tallow, offal and brain. More than 30% participants knew that diabetic patients were strongly encouraged to eat tempeh. Overall, one-third of participants gave correct answers (31.0-50.0%) while the other two-thirds were either gave wrong answers or didn't know the answers. Overall, knowledge of diabetes among rural community in Cisalak Village was considered as very low.

The association between nutrition status and blood glucose status (pre-diabetes/diabetes) was analyzed by four indicators, namely BMI, BFP, WC and visceral fat. This study indicated that there were two factors which were significantly related to blood glucose status and two other factors which were not. Two factors having significant association with blood glucose status were WC (OR = 3.280, 95% CI: 1.093-9.843) and visceral fat (OR = 2.882, 95% CI: 0.983-8.455). Two other factors having no significant association with blood glucose status but had a tendency toward risky status were BMI (OR = 0.124, 95% CI: 0.782-6.797) and BFP (OR = 1.400, 95% CI: 0.487-4.026).

DISCUSSION

Blood glucose status (pre-diabetes/diabetes) was affected by insulin resistance. Insulin resistance is a condition of decreased ability of insulin, causing the failure of the body's metabolic functions. This condition is caused by a decreased level of insulin sensitivity so

Table 5: Association between nutritional status and blood glucose

	Blood glucose status							
	Pre-diabetes/ diabetes		Non-diabetes		--- Total ---			
Nutritional status	n	%	n	%	n	%	p-value	OR
BMI (kg/m^2)								
Obese (≥25.0)	8	32.0	17	68.0	25	100	0.124	2.306 (0.782-6.797)
Non-obese (<25.0)	10	16.9	49	83.1	29	100		
BFP (%)								
Obese (Men: ≥24%, Women: ≥35%)	8	25.0	24	75.0	32	100	0.531	1.400 (0.487-4.026)
Non-obese (Men: <24%; Women: <35%)	10	19.2	42	80.8	52	100		
WC (cm)								
Obese (Men: ≥90 cm, Women: ≥80 cm)	12	32.4	25	67.6	37	100	0.029*	3.280 (1.093-9.843)
Non-obese (Men: <90 cm; Women: <80 cm)	6	12.8	41	87.2	47	100		
Visceral fat								
Obese (≥10.0)	9	34.6	17	65.4	26	100	0.049*	2.882 (0.983-8.455)
Non-obese (<10)	9	15.5	49	84.5	58	100		

*Chi-square test, significant at α <5%. Abbreviation: BMI: Body mass index, BFP: Body fat percentage, WC: Waist circumference

that β cells are stimulated to work hard to meet the metabolic needs. As a result of this, plasma insulin levels increased which is commonly known as hyperinsulinemia (Effendi, 2013).

Prediabetes is a condition in which the blood glucose level is above normal but not high enough to be categorized as diabetes. It is defined as a fasting blood glucose level in the interval of 100-125 mg/dl (Nathan *et al*., 2007). DM is a metabolic disorder condition determined by the degree of hyperglycemia (elevated fasting blood glucose) where the fasting blood glucose is ≥126 mg/dl (WHO, 2006).

Blood glucose status (pre-diabetes/diabetes) was found more often in women than men. This finding was consistent with the previous study by Waspadji *et al*. (2013) in rural areas in Ende, East Nusa Tenggara where it was known that diabetic status (pre-diabetes/diabetes) was higher in women than men. Another study in rural areas in Bali Province by Suastika *et al*. (2011) also showed the same results. This study concluded that the blood glucose status of women was higher than the men's. Results of Mann-Whitney test showed that there was no significant difference in blood glucose status between rural men and women ($p = 0.597$). This result differed from the previous study by Kim *et al*. (2013) in rural areas located in New Ulm, United States of America who found that there was significant difference in blood glucose status (pre-diabetes/diabetes) between rural men and women aged 40-79 years ($p<0.001$). The number of men and women who were categorized as pre-diabetes/diabetes in this study was relatively small because physical activities of the rural communities were higher than urban communities. However, physical activities of rural men were higher than rural women who tended to be less active (Table 2).

Nutrition knowledge is a knowledge of food and nutrients, source of nutrients in food, food safe to consume so as not to cause disease, how to process food properly so that the nutrients in food are not lost and how to live a healthy life (Notoadmodjo, 2003).

Nutrition knowledge about diabetes assessed in this study were general knowledge, knowledge about the risk factors, knowledge about the disease and its complications and knowledge of high-risk food. Nutrition knowledge of rural residents (men and women) who suffered from diabetes was still relatively low (<60%). This result was consistent with the study by Lorga *et al*. (2012) who stated that the majority of public knowledge about diabetes was low and very alarming. Therefore, interventions such as nutrition education needs to be done so that the knowledge can be increased. Low nutrition knowledge was caused by the lack of education of the rural communities because most of them had only six or less than six years of education. This was in accordance with the opinion of Chilton *et al*. (2006) who stated that the higher a person's education was, the higher the level of nutrition knowledge about diabetes he had (Table 4).

Pre-diabetes/diabetes group and non-diabetes group had low nutrition knowledge. However, if observed by the mean value, nutrition knowledge of pre-diabetes/ diabetes group was higher than non-diabetes group. Thus, pre-diabetes/diabetes group was more aware of the importance of maintaining a healthy lifestyle. This finding was in accordance with the opinion of Lorga *et al*. (2012) who stated that higher public knowledge would increase the awareness and became a key determinant in improving the lifestyle and behavior in a community. Higher education would make people become more concerned with their health and provide benefit in changing their behavior toward healthier lifestyle (Shafaee *et al*., 2008; Alaboudi *et al*., 2014).

Obesity in middle-aged men and women would have big impact on the incidence of diabetes. People having BMI in obese category had a higher risk of having pre-diabetes/diabetes. Meanwhile, middle-aged people who were obese and also overweight had a higher mortality

risk than the ones who were overweight only (Zoppini *et al*., 2003; Bays *et al*., 2007; Perry *et al*., 2012). Based on BMI category, obesity had no significant association with blood glucose status (pre-diabetes/diabetes). However, obese people had a tendency to have 2.306 times higher risk of pre-diabetes/diabetes (Table 5). Several studies indicated that overweight and obesity were included as causal factors of diabetes (Ganz *et al*., 2014; Tobias *et al*., 2014; Jerant *et al*., 2015).

Measuring body composition by BIA was a noninvasive and valid method that allowed separation of the body mass into bone mass, fat mass and fat-free mass. It could also gave estimation for the regional body composition (Gallagher and Song, 2003). Obesity was an established risk factor for non-insulin dependent diabetes melitus (Carey *et al*., 1997). Body fat percentage (BFP) was a predictor for risk factors of type 2 diabetes (Meisinger *et al*., 2006). BFP in adults who were just diagnosed having type 2 diabetes melitus was related to insulin sensitivity and glucose homeostasis (Aghili *et al*., 2014).

BFP had no significant association with blood glucose status but people with high BFP tended to have 1.4 times higher risk of pre-diabetes/diabetes (Table 5). This result was in contrast with previous study by Soniya *et al*. (2014) who stated that BFP was associated with BMI and played a role in the incidence of Type 2 DM. Women's BFPs were higher than men's. Therefore, they were at higher risk of having Type 2 DM.

WC was a better predictor than BMI in detecting several outcomes, including the incidence of diabetes, cardiovascular disease (CVD), cardiovascular disease mortality and all-cause mortality. The use of WC appeared to be better in Asian than in non-Asian populations. BMI was not superior to WC in any of the evaluated outcomes (Huxley *et al*., 2010; Savva *et al*., 2013; Hajian-Tilaki and Heidari, 2015). Based on waist circumference (WC), WC over 90 cm in men and over 80 cm in women were significantly related to blood glucose status. Rural men and women, who were categorized as obese based on WC, were 3.28 times at higher risk of having pre-diabetes/diabetes. This finding was consistent with the study by Meisinger *et al*. (2006) who showed that WC was associated with the incidence of Type 2 DM. Men with WC over 90 cm and women with WC over 80 cm were at risk of having DM. Mirarefin *et al*. (2014) stated that WC in obese category had effect on insulin resistance and caused metabolic disorders. WC in this category was related to metabolic components such as high triglyceride levels, low HDL-C levels and high blood glucose levels.

Visceral fat accumulation was one of the basic clinical condition of metabolic syndrome (MetS), which was a major risk factor for CVD. The clustering of cardio-vascular risk factors, such as elevated glucose, dyslipidemia and raised blood pressure, had been shown to have a synergistic effect on the development of atherosclerosis. MetS had received much attention due to its association with an increased risk for CVD and thus, it was considered an important target for the prevention of CVD (Unno *et al*., 2012). Visceral obesity was associated to higher incidence of type 2 diabetes and insulin resistance which were considered as important causes of mortality and high costs in the world (Tchernof and Despres, 2013)

Visceral fat, greater than 10.0, was significantly related to blood glucose status (pre-diabetes/diabetes) of rural men and women. Those with visceral fat greater than 10.0 were 2.882 times at higher risk of having high blood glucose status (pre-diabetes/diabetes). This result was consistent with the study by Anjana *et al*. (2004) stating that visceral fat had strong correlation with the incidence of diabetes. High visceral fat in obese people had stronger correlation to the incidence of diabetes than the one in people with normal nutritional status. Visceral fat was directly proportional to the diameter of abdominal circumference and the composition of abdominal fat. Visceral fat and abdominal fat were associated with the incidence of Type 2 DM. Both of visceral fat and abdominal fat correlated with each other on WC and sagittal abdominal diameter (SAD). In addition, visceral fat was also affected by age and gender in relation to the incidence of diabetes.

Conclusion and recommendation: The results of this study indicated that there was no significant difference in diabetic status between men and women. All participants had low nutrition knowledge. Nutrition knowledge in pre-diabetes/diabetes group were higher than non-diabetes group. Results of bivariate analysis showed that there were significant associations between WC (OR = 3.280; 95% CI: 1.093-9.843) and visceral fat (OR = 2.882; 95% CI: 0.983-8.455) with blood glucose status (pre-diabetes/diabetes) in rural men and women.

Generally, rural men and women had low nutrition knowledge. Therefore, nutrition education such as counseling is needed so that the nutrition knowledge in community can be increased. Overweight in general had an impact on the blood glucose status (pre-diabetes/diabetes) in rural men and women. Therefore, it is necessary to socialize the importance of maintaining body weight by adopting a healthy lifestyle such as quit smoking, regular exercise and reduce the consumption of sweetened beverages or foods.

Pre-diabetes/diabetes group generally had low nutrition knowledge. Therefore, nutrition education on the importance of maintaining a normal weight needs to be done to avoid the risks and complications due to high blood sugar status. Socialization to general public is also needed, particularly about the importance of maintaining body weight by adopting healthy lifestyle

such as not smoking, regular exercise and lessening the consumption of sweet food or sugar-sweetened beverages, in order to maintain blood glucose status.

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