The Role of Alcohol Consumption and Smoking Habits in Increasing the Diabetes Mellitus Risk in Adult Men and Women with Central Obesity in Indonesia: A Cross-Sectional National Study

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ABSTRACT

Central obesity is more predictive of measuring the risk of type 2 diabetes compared to anthropometric indicators of general obesity. The results of previous studies are still inconsistent and the causal relationship that had not been well explained between the determinant factors and the increasing incidence of diabetes mellitus. This study aims to determine the relationship between alcohol consumption and smoking habits in increasing the risk of diabetes mellitus in adult males and females who are central obesity in Indonesia. The analysis presented in this study was based on the data from a population-based, cross-sectional, nationally representative survey (Indonesian Basic Health Research 2018/RISKESDAS 2018). In total, 12726 men and 18637 women aged 18–65 years were enrolled. A validated questionnaire, smoking card, and alcohol card were used for the assessments. There was a significant difference ($p < 0.000$) in the proportion of diabetes mellitus incidence between men and women in both age groups who consumed less than 1 pack of cigarettes or more than 1 pack per day. The age difference for the sexes did not show a statistically significant association with alcohol consumption of either under 5 servings or above 5 servings per day for the incidence of diabetes mellitus. Women with central obesity had an adjusted prevalence ratio of 1.7 times higher for diabetes mellitus than men. There were negative multiplicative interactions between sexes and smoking status (interaction PR = 0.685; 95% CI = 0.52-0.88) and cigarette exposure (0.65; 0.52-0.80) in women. The effects of alcohol consumption and their interactions with sex did not have a significant relationship. There is an increased risk of diabetes mellitus especially in women with central obesity. Alcohol consumption by people with central obesity has an interaction with gender in an increased risk of diabetes mellitus which is higher in women than men.

Keywords: *Central obesity, diabetes mellitus, smoking, alcohol.*

INTRODUCTION

Diabetes mellitus is a chronic and progressive disease with an increasing prevalence and evidence during the last few decades around the world. The International Diabetes Federation (2017) states that the prevalence of diabetes mellitus in the world is 8.8% or about 425 million adults and is expected to increase to 9.9% in 2045. The prevalence of diabetes mellitus in Indonesia is increasing very rapidly from 5.7% in in 2007 to 6.9% in 2013 and increased to 8.5% in 2018(1). These results place Indonesia as one of the countries with the highest diabetes mellitus in the world with an estimated number of 10.3 million in 2017 and is estimated to increase to 16.7 million in 2045(2). Diabetes mellitus was responsible for 4 million adult deaths in 2017, which is the equivalent of one death every eight seconds. This disease also provides significant economic losses for the country, the health system, especially for people with diabetes and their families through direct medical costs and loss of jobs and wages(2,3). In the past decade, it is estimated that health spending for adult diabetics has increased from $232 billion to $727 billion worldwide(2).

Being overweight is the most important modifiable risk factor for the development of type 2 diabetes because 85-90% of people with type 2 diabetes are either overweight or obese. Waist circumference and waist-to-hip ratio as central anthropometric indicators of obesity are more predictive of the risk of developing type 2 diabetes compared to anthropometric indicators of obesity through body mass index measurement(4). A broad waist circumference indicates a high accumulation of abdominal fat. Central obesity as a clinical feature of excessive visceral fat accumulation is closely related to diabetes mellitus(5,6). The prevalence of central obesity in Indonesia increased very rapidly from 18.8% in 2007 to 26.6% in 2013 and increased to 31% in 2018(1).

Diet has a major role in the development of central obesity. Alcoholic drinks contain quite high energy. The contribution of calories to alcohol in energy intake (7.11 kcal/g) falls between carbohydrates (4 kcal/g) and fat (9 kcal/g). Alcohol consumption ≥30 g per day contributes to an increased risk of diabetes and central obesity, increased blood glucose concentration, and high blood pressure, especially in men(7). A cross-sectional study showed that the total alcohol intake of men and women was directly related to high body mass index (≥30.0kg/m^2) and broad waist circumference (≥102 cm in men and ≥88 cm in women)(8). Research by Park and Buja conducted on Korean and Italian

societies shows that alcohol consumption will have a negative impact only on male groups(9,10). A contrasting impact arises when alcoholic drinks are consumed in low to moderate amounts. Metaanalysis studies show that the prevalence of metabolic syndrome is two times lower in the group of women who consume moderate amounts of alcoholic beverages(7,11,12).

Various community-based studies have shown that smoking is associated with high central obesity even though smokers have a low body weight or body mass index(13,14,15,16,17,18). Although a lot of epidemiological evidence shows that there is a positive relationship between smoking habits and diabetes mellitus(19,20,21), various studies show insignificant results and even a negative relationship between the two(22,23,24,25). Recent research from Wang shows that smoking is negatively associated with the incidence of type 2 diabetes in men of normal weight in China, but not significantly in the obese male or female group(26). A positive relationship from smoking actually appears related to the incidence of central obesity(27,28) and stroke(26) in people with type 2 diabetes.

The results of the research are still inconsistent and the causal relationship that cannot be well explained between the determinant factors and the increasing incidence of diabetes mellitus in Indonesia can be caused by other smaller-scale studies that have not considered potential confounding factors such as race and genetic factors, gender, status, general obesity and central obesity, frequency and amount of alcohol intake, physical activity, disease history, and smoking habits. This study aims to determine the relationship between alcohol consumption and smoking habits in increasing the risk of diabetes mellitus in adult males and females who are central obesity in Indonesia. National scale data from Riskesdas 2018 is used to help provide results that can be applied in an effort to reduce the risk of diabetes mellitus in the entire population.

METHODS

We used a population-based, cross-sectional, nationally representative survey (Indonesia Basic Health Research 2018/Riskesdas 2018/Riset Kesehatan Dasar 2018) conducted by the National Instituteof Health Research Development (NIHRD), Ministry of Health, Indonesia. A two-stage stratifified clustersampling method was used to draw the study sample from 34 provinces of the 514 Indonesian districts. Complete interviewswere conducted for 282.654 households from the targeted 300,000 households. The 1.091.528 participants were aged from 0 months to 75 years in the national survey, but ourstudy only focused on participants aged 18–65 years. In total, 12726 men and

18637 women aged 18–65 years were enrolled.

First, we examined the characteristics of research participants according to gender and ageby using percentage. Second,*chi-square* tests were conducted to explore gender and age diferences in education, residency, and other variables. Third, the odds ratio (OR) and 95% confidence intervals (CIs) for the association of factors related to sociodemographic factors, smoking habits, and alcohol consumption with the incidence of diabetes mellitus in people with central obesity were estimated using logistic regressionanalysis. We controlled for all variables, such as residency, gender, age, education level, smoking and alcohol consumption in the regression analysis. In addition, we also stratified the models by smoking and alcohol consumption to investigate potential smoking and alcohol consumption diference in these associations. The IBM SPSS Statistics software (version. 23) was used for data analysis. The statistical threshold for significance was considered at $p \leq 0.05$.

RESULTS

Characteristics of research participants

All information in this study was obtained through Indonesia Basic Health Research 2018/Riskesdas 2018/Riset Kesehatan Dasar 2018. This data includes 31,363 people aged 18-65 years with central obesity for analysis of the role of alcohol consumption and smoking habits in the increased risk of diabetes mellitus in males and females with central obesity in Indonesia. There is no missing data after cleaning, so there is no drop out number in the data.

Table 1: Characteristics of research participantsaccording to gender and age

Variables	Men				*p* value
	Young	%	Middle-Aged	%	
Education level					
Graduate	282	7,3	612	6,9	,358
Non-graduate	3559	92,7	8273	93,1	
Occupation					
Working	3017	78,5	8326	93,7	,000*
Unemployed	824	21,5	559	6,3	
Residency					
Urban	2003	52,1	4275	48,1	,000*
Rural	1838	47,9	4610	51,9	
Smoking Status					
Non-smoker	935	24,3	1945	21,9	
Smoking occasionally	576	15,0	1359	15,3	,010*
Smoking everyday	2330	60,7	5581	62,8	
Smoking habit					
Never smoking	935	24,3	1945	21,9	,002*
Smoking	2906	75,7	6940	78,1	
Smoking exposure					
Non-exposed	255	6,6	830	9,3	,000*
Exposed	3586	93,4	8055	90,7	
Number of cigarettes					
Non-smoker	943	24,6	1954	22,0	
1-2 pack/day	2531	65,9	5799	65,3	,000*
2-3 pack/day	313	8,1	937	10,5	
≥3 pack/day	54	1,4	195	2,2	
Alcohol consumption					
Non-alcoholic	3499	91,1	8623	97,1	
1-2 portion/day	188	4,9	146	1,6	,000*
3-5 portion/day	83	2,2	66	0,7	
>5 portion/day	71	1,8	50	0,6	

p values were from the Chi-squared test.

Variables	Women				*p* value
	Young	%	Middle-Aged	%	
Education level					
Graduate	526	8,4	677	5,5	,000*
Non-graduate	5768	91,6	11666	94,5	
Occupation					
Working	2450	38,9	6470	52,4	,000*
Unemployed	3844	61,1	5873	47,6	
Residency					
Urban	3249	51,6	6415	52,0	,649

Rural	3045	48,4	5928	48,0	
Smoking Status					
Non-smoker	6122	97,3	11689	94,7	
Smoking occasionally	118	1,9	351	2,8	,000*
Smoking everyday	54	0,9	303	2,5	
Smoking habit					
Never smoking	6122	97,3	11689	94,7	,000*
Smoking	172	2,7	654	5,3	
Smoking exposure					
Non-exposed	1302	20,7	3232	26,2	,000*
Exposed	4992	79,3	9111	73,8	
Number of cigarettes					
Non-smoker	6125	97,3	11691	94,7	
1-2 pack/day	162	2,6	622	5,0	,000*
2-3 pack/day	6	0,1	23	0,2	
≥3 pack/day	1	0,0	7	0,1	
Alcohol consumption					
Non-alcoholic	6264	99,5	12315	99,8	
1-2 portion/day	18	0,3	20	0,2	,015*
3-5 portion/day	2	0,0	3	0,0	
>5 portion/day	10	0,2	5	0,0	

p values were from the Chi-squared test.

The characteristics of all study subjects are presented in Table 1. Adult males and females with central obesity were divided into two age category groups. The 18-35 year olds were categorized into young age and 36-65 years into the middle-age category. The proportion of women with central obesity who do not work is higher than that of men. In general, more centrally obese men are often exposed to secondhand smoke and have smoking and alcohol consumption in larger portions than women.

Relationship between the characteristics of research subjects and diabetes mellitus

Women with central obesity had a 1.7 times greater risk of developing diabetes mellitus than men for the same condition (95% CI). Table 2 also shows that the increasing age of a person who has central obesity will be followed by an increased risk of suffering from diabetes mellitus. The 36-65 year age group had a 4 times greater risk of developing diabetes mellitus compared to younger people aged 18 to 35 years (95% CI).

Table 2: Relationship between sociodemographic factors, smoking habits, and alcohol consumption with the incidence of diabetes mellitus in people with central obesity

Variables	Diagnose				*p* value	*OR*
	Non Diabetes melitus	%	Diabetes melitus	%		
Sex						
Men	11771	92,5	955	7,5		
Women	16345	87,7	2292	12,3	,000*	1,728
Age						
Young	9762	96,3	373	3,7		
Middle-aged	18354	86,5	2874	13,5	,000*	4,098
Education level						
Graduate	1911	91,1	186	8,9		
Non-graduate	26205	89,5	3061	10,5	,021*	1,2
Occupation level						
Working	18298	90,3	1965	9,7		
Unemployed	9818	88,5	1282	11,5	,000*	1,216
Residency						
Urban	14283	89,6	1659	10,4		
Rural	13833	89,7	1588	10,3	,752	0,988
Smoking Status						
Non-smoker	18200	88,0	2491	12,0		
Smoking occasionally	2175	90,5	229	9,5	,000*	0,769
Smoking everyday	7741	93,6	527	6,4	,000*	0,497
Current smoking status						
Ex-smoker	1465	88,7	450	5,8		
Smoking occasionally	1196	90,9	120	9,1	,056	0,790
Smoking everyday	7255	94,2	186	11,3	,000*	0,489
Smoking habit						
Non-smoker or ex-smoker	19665	88,0	2677	12,0		
Active smoking	8451	93,7	570	6,3	,000*	0,495
Smoking exposure						
Non-exposed	4835	86,0	784	14,0		
Exposed	23281	90,4	2463	9,6	,000*	0,652
Number of cigarettes						
Non-smoker	18221	88,0	2492	12,0		
<1 pack/day	8481	93,1	633	6,9	,000*	0,546
>1 pack/day	1414	92,1	122	7,9	,000*	0,631
Alcohol consumption						
Non-alcoholic	27489	89,5	3212	10,5		
<5 portion/day	472	94,4	28	5,6	,001*	0,508
>5 portion/day	155	95,7	7	4,3	,014*	0,387

p values were from the Chi-squared test.

Central obesity adults who did not have tertiary education or who were unemployed had a 1.2 times higher risk of developing diabetes mellitus than those who had completed tertiary education or were employed (95% CI). The area of residence did not show a statistically significant relationship with the incidence of diabetes mellitus in adults with central obesity (p 0.752). Smoking habits seen from various aspects such as smoking status, cigarette exposure, and the number of cigarettes consumed have a negative relationship with the incidence of diabetes mellitus in people with central obesity. People who never consumed alcohol had a tendency to develop diabetes mellitus 1.96 times and 2.58 times greater than those who consumed alcohol <5 servings (p 0.001) and> 5 servings (p 0.014) per day.

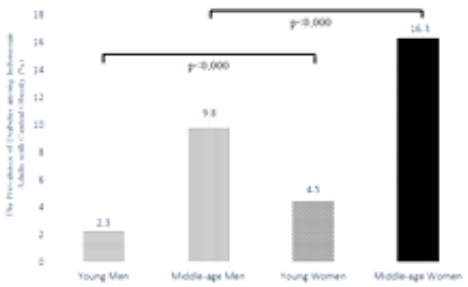

Figure 1: Prevalence of diabetes mellitus in indonesians with central obesity

Figure 1 shows a significant difference in the prevalence of diabetes mellitus in people with central obesity. In the young age group, the prevalence of diabetes mellitus was significantly higher in women than in men. Significant results were also found in the middle-age group. The prevalence of diabetes mellitus in people with central obesity increases with age. In women in the age range of 56-65 years, the prevalence of diabetes mellitus has decreased. The prevalence of diabetes mellitus was significantly higher in women compared to men in all age ranges (Figure 2).

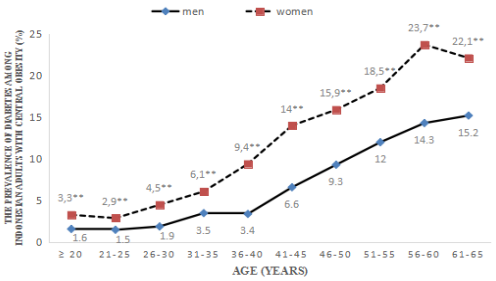

Figure 2: Prevalence of diabetes mellitus by age *Footnote: **p* Value <0,000

There was a significant difference (p <0.000) in the proportion of diabetes mellitus incidence between men and women in both age groups who consumed less than 1 pack of cigarettes or more than 1 pack per day. Age differences for both sexes did not show a statistically significant association (p 0.094 young age and p 0.171 middle-age) with alcohol consumption of either under 5 servings or above 5 servings per day for the incidence of diabetes mellitus (Figure 3).

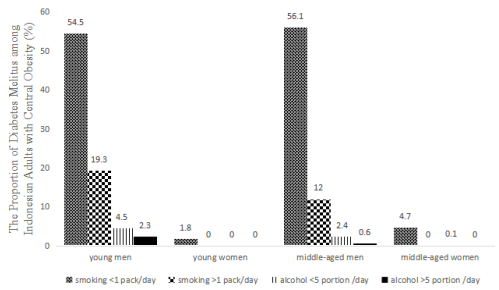

Figure 3: Prevalence of Diabetes Mellitus in Adults with Central Obesity by Age, Gender, and Consumption of Cigarettes and Alcohol

The stratification analysis of smoking status was carried out based on alcohol consumption, gender, age group, educational status, employment status, and living area to determine whether these variables influenced the relationship between smoking habits and the incidence of diabetes mellitus in people with central obesity. In smokers, almost all of the variables studied had a negative association with the risk of developing diabetes mellitus in people with central obesity. Compared to the group without tertiary education, the risk of developing diabetes mellitus was higher in smokers who had completed tertiary education, but this association was not statistically significant (Table 3).

Table 3: The stratification of smoking against diabetes mellitus according to alcohol consumption, gender, age group, educational status, work status, and area of residence

Strata	Smoking status	Diagnose of Diabetes mellitus		OR	*p*	95% CI
		No	Yes			
Alcohol consumption						
Non-alcoholic	Non smoker	18115	2484			
	Smoker	9374	728	0,56	,000*	0,52-0,61
Alcoholic	Non smoker	84	7			
	Smoker	542	28	0,627	,284	0,26-1,48
				0,557*		0,51-0,60
				0,567*		0,52-0,61
Sex						
Men	Non smoker	2580	300			
	Smoker	9191	655	0,613	,000*	0,53-0,70
Women	Non smoker	15620	2191			
	Smoker	725	101	0,993	,950	0,80-1,21
				0,557*		0,51-0,60
				0,72*		0,63-0,81
Age						
Young	Non smoker	6754	303			
	Smoker	3008	70	0,519	,000*	0,39-0,67
Middle-aged	Non smoker	11446	2188	0,557*		0,51-0,60
	Smoker	6908	686	0,519	,000*	0,47-0,56
				0,557*		0,51-0,60
				0,519*		0,47-0,56
Education Level						
Graduate	Non smoker	1380	132			
	Smoker	531	54	1,663	,718	0,76-1,48
Non-graduate	Non smoker	16820	2359			
	Smoker	9385	702	0,53	,000*	0,48-0,58
				0,557*		0,51-0,60
				0,556*		0,51-0,60
Occupation						
Working	Non smoker	9626	1320			
	Smoker	8672	645	0,54	,000*	0,49-0,59
Unemployed	Non smoker	8574	1171			
	Smoker	1244	111	0,65	,000*	0,53-0,80
				0,557*		0,51-0,60
				0,563*		0,51-0,61
Residency						
Urban	Non smoker	9468	1278			
	Smoker	4815	381	0,58	,000*	0,52-0,60
Rural	Non smoker	8732	1213			
	Smoker	5101	375	0,52	,000*	0,46-0,59
				0,557*		0,51-0,60
				0,557*		0,51-0,60

There is a quite large difference between the crude odd ratio value and the Mantel-Haenszel odd ratio on the gender variable. This suggests that gender is a confounder for the association of smoking status with the incidence of diabetes mellitus in people with central obesity.

Table 4: Stratification of alcohol consumption on diabetes mellitus according to smoking status, gender, age group, educational status, work status, and area of residence

Strata	Alcohol consumption	Diagnose of diabetes melitus		OR	*p*	95% CI
		No	Yes			
Smoking status						
Non-smoker	Non-Alcoholic	18115	2484			
	Alcoholic	85	7	0,601	,191	0,27-1,29
Smoker	Non-Alcoholic	9374	728			
	Alcoholic	542	28	0,665	,038*	0,45-0,98
Crude OR				0,478		0,33-0,67
MH OR				0,651		0,46-0,92
Sex						
Men	Non-Alcoholic	11199	923			
	Alcoholic	572	32	0,679	,035*	0,47-0,97
Women	Non-Alcoholic	16290	2289			
	Alcoholic	55	3	0,388	,098	0,12-1,24
Crude OR				0,478		0,33-0,67
MH OR				0,638		0,45-0,90
Age						
Young	Non-Alcoholic	9396	367			
	Alcoholic	366	6	0,420	,031*	0,18-0,94
Middle-aged	Non-Alcoholic	18093	2845			
	Alcoholic	261	29	0,707	,076	0,48-1,03
Crude OR				0,478		0,33-0,67
MH OR				0,628		0,44-0,88
Education Level						
Graduate	Non-Alcoholic	1869	183			
	Alcoholic	42	3	0,730	,599	0,22-2,37
Non-graduate	Non-Alcoholic	25620	3029			
	Alcoholic	585	32	0,463	,000*	0,32-0,66
Crude OR				0,478		0,33-0,67
MH OR				0,478		0,33-0,67
Occupation						
Working	Non-Alcoholic	17775	1932			
	Alcoholic	523	33	0,581	,002*	0,40-0,82
Unemployed	Non-Alcoholic	9714	1280			
	Alcoholic	104	2	0,146	,002*	0,03-0,59
Crude OR				0,478		0,33-0,67
MH OR				0,496		0,35-0,69
Residency						
Urban	Non-Alcoholic	13961	1640			
	Alcoholic	322	19	0,502	,003*	0,31-0,80
Rural	Non-Alcoholic	13528	1572			
	Alcoholic	305	16	0,451	,002*	0,27-0,74
Crude OR				0,478		0,33-0,67
MH OR				0,478		0,33-0,67

The quite large difference in the odds ratio in each class group in the gender and education variables indicates that these two variables are effect modifiers of the incidence of diabetes mellitus with smoking status in people who are centrally obese.

In centrally obese adults who consumed alcohol, all of the variables studied had a negative association with the risk of developing diabetes mellitus (Table 4). Smoking status, gender, and age group were confounders for the association of alcohol consumption with the incidence of diabetes mellitus in people with central obesity. Age group, education, and employment status are effect modifiers on the incidence of diabetes mellitus with alcohol consumption in people who are centrally obese.

Interactions among the determinant factors of diabetes mellitus

Table 5 shows the relationship between the determinants of diabetes mellitus in people with central obesity based on gender. Increasing age will increase the risk of diabetes mellitus in men and women who are centrally obese. Women who do not have tertiary education and live in rural areas have a higher risk of developing diabetes mellitus than men with the same

condition. Smoking status, cigarette exposure, and alcohol consumption have a negative relationship with the incidence of diabetes mellitus. However, this only happened to men.

Table 5: Diabetes mellitus prevalence ratio according to gender

Variables	PR	95% CI	*p* Value
Men			
Age (middle-aged vs young)	4,612	3,69-5,76	,000*
Education Level(non-graduate vs graduate)	0,677	0,54-0,84	,001*
Occupation (unemployed vs working)	0,991	0,80-1,22	,932
Residency (rural vs urban)	0,885	0,77-1,01	,070
Smoking status (smoker vs non-smoker)	0,613	0,53-0,70	,000*
Smoke exposure (exposed vs non-exposed)	0,518	0,42-0,62	,000*
Alcohol Consumption (alcoholic vs non-alcoholic)	0,679	0,47-0,97	,035*
Women			
Age (middle-aged vs young)	4,094	3,60-4,65	,000*
Education Level(non-graduate vs graduate)	1,723	1,38-2,13	,000*
Occupation (unemployed vs working)	0,969	0,88-1,05	,475
Residency (rural vs urban)	1,056	0,96-1,15	,228
Smoking status (smoker vs non-smoker)	0,993	0,80-1,22	,950
Smoke exposure (exposed vs non-exposed)	0,795	0,72-0,87	,000*
Alcohol Consumption (alcoholic vs non-alcoholic)	0,388	0,12-1,24	,098

Multivariable analysis performed with logistic regression tests produced several regression models in analyzing the relationship between the incidence of diabetes mellitus in centrally obese adults and the factors that influence it. In the existing model, women with central obesity had an adjusted prevalence ratio of 1.7 times higher for diabetes mellitus than men. There were negative multiplicative interactions between sex and smoking status (interaction prevalence ratio = 0.685; 95% CI = 0.52-0.88) and exposure to smoking (0.65; 0.52-0.80) in women. The effects of alcohol consumption and their interactions with sex did not have a significant relationship.

Table 6: Diabetes mellitus prevalence ratio with respect to sociodemographic variables, smoking status, alcohol consumption, and their interactions

Variables	PR	95% CI	*p* Value	*Psudo* R^2
MODEL 1				
Sex(women vs men)	1,704	1,35-2,14	,000*	7,3%
Age (middle-aged vs young)	4,331	3,87-4,84	,000*	
Education Level(non-graduate vs graduate)	1,117	0,95-1,30	,173	
Occupation (unemployed vs working)	1,145	1,05-1,24	,001*	
Smoking status (smoker vs non-smoker)	,857	0,69-1,06	,159	
Sex * Smoking Status	,685	0,52-0,88	,004*	
MODEL 2				
Sex(women vs men)	1,761	1,60-1,93	,000*	7,3%
Age (middle-aged vs young)	4,245	3,79-4,74	,000*	
Education Level(non-graduate vs graduate)	1,123	0,95-1,31	,153	
Occupation (unemployed vs working)	1,140	1,04-1,24	,002*	
Smoke exposure (exposed vs non-exposed)	0,850	0,76-0,93	,001*	
Sex * Smoke exposed	0,650	0,52-0,80	,000*	
MODEL 3				
Sex(women vs men)	0,886	0,25-3,02	,847	7%
Age (middle-aged vs young)	4,295	3,84-4,80	,000*	
Education Level(non-graduate vs graduate)	1,072	0,91-1,25	,387	

Occupation (unemployed vs working)	1,153	1,06-1,25	,001*	
Alcohol Consumption (alcoholic vs non-alcoholic)	0,487	0,15-1,57	,230	
Sex * Alcohol Consumption	1,931	0,56-6,61	,295	
MODEL 4				
Sex(women vs men)	1,711	1,36-2,14	,000*	7,4%
Age (middle-aged vs young)	4,278	3,82-4,78	,000*	
Education Level(non-graduate vs graduate)	1,145	0,97-1,34	,096	
Occupation (unemployed vs working)	1,137	1,04-1,23	,003*	
Smoking Status (smoker vs non-smoker)	0,885	0,71-1,09	,269	
Smoke exposure (exposed vs non-exposed)	0,54	0,77-0,94	,002*	
Sex * Smoking Status	0,733	0,56-0,96	,024*	
Sex * Smoke exposed	0,828	0,82-1,05	,120	

In the last model, sex, age, occupational status, cigarette exposure and smoking status interactions with sex have a significant and stable relationship. The ability of all independent variables in explaining the incidence of diabetes mellitus is shown by the pseudo R2 value in this model of 7.4%. This means that there are still 92.6% of other factors outside the model that explain the incidence of diabetes mellitus in adults with central obesity. Although this model has the highest predictive value compared to other models, this model is not a simple model capable of explaining the incidence of diabetes mellitus in people with central obesity.

DISCUSSION

In this population-based study it was identified that there is a very close relationship between the risk of diabetes mellitus in centrally obese adults with an increase in age and gender, especially in women. Smoking habits and alcohol consumption have a negative relationship with the incidence of diabetes mellitus in centrally obese adults, but only significant in the male group. After adjusting for age, education level, occupation, the effect of female gender on central obesity was persistent and significant compared with men. There is also a positive interaction between the incidence of diabetes mellitus and alcohol consumption, especially in women, although it is not statistically significant.

The International Diabetes Federation (2017) states that the prevalence of diabetes mellitus in the world is 8.8% or about 425 million adults and is expected to increase to 9.9% in 2045. The prevalence of diabetes mellitus in Indonesia is increasing very rapidly from 5.7% in in 2007 to 6.9% in 2013 and increased to 8.5% in 2018(1). The results of the 2018 Riskesdas showed that the prevalence of diabetes mellitus based on a doctor's diagnosis in adult women in Indonesia was 2.4%, while in men it was 1.7%. The same data shows an increase in the prevalence of diabetes based on examination of blood sugar levels using the 2015 Perkeni consensus, namely 12.7% in adult women and 9.0% in adult men. The highest prevalence of diabetes (19.6%) is in the age group over 55 years(1).

In the early adult age group, the prevalence of diabetes mellitus in people with central obesity was significantly higher in women (4.5%) than in men (2.3%). Significant results were also found in the late adult age group. The prevalence of diabetes mellitus in people with central obesity increases with age. In women in the age range of 56-65 years, the prevalence of diabetes mellitus has decreased. The prevalence of diabetes mellitus in people with central obesity is significantly higher in women than in men in all age ranges.

In this study, before adjusting with alcohol consumption, the risk of diabetes mellitus in women with central obesity was higher than that of men with central obesity related to smoking behavior. The negative relationship between smoking habits and the incidence of diabetes mellitus has also been shown by several previous studies(22,23,24,25). Recent research from Su(26) shows that smoking is negatively associated with the incidence of type 2 diabetes in men in China, but not significantly in the female group. Smoking habits are associated with insulin resistance, inflammation, and dyslipidemia, but the exact mechanism regarding the effect of smoking on the incidence of diabetes mellitus is still not well explained(29). Inconsistent results between men and women were thought to be related to differences in smoking intensity, density, and duration. In Indonesia, Riskesdas data shows that only 1.2% of women over the age of 10 smoke every day, which is significantly lower than the proportion of men who smoke every day of 47.3%(1).

Alcohol consumption indicates a positive multiplicative effect on the risk of diabetes mellitus in women with central obesity, but it is not statistically significant. In the female group, alcohol consumption from 10.1 g to 15.0 g per day was associated with a higher risk of abnormal blood glucose concentrations(7). Alcohol contributes to 7,11 kcal / g of calories in energy intake. The proportion of women who consume alcohol in Indonesia is 0.4% (6.1% men) and 0.0% (1.7% men) for consuming alcohol in risky portions (above 5 servings per day or 50 g of pure ethanol per day).

Compared with the group who did not consume alcohol, a protective effect against diabetes mellitus appeared in the group who consumed alcoholic beverages. Previous meta-analysis studies showed that the prevalence of metabolic syndrome was two times lower in the group of women who consumed moderate amounts of alcoholic beverages(7,11,12). Suliga(7) found that alcohol consumption is closely related to an increase in HDL cholesterol levels. The results in this study are different from the results of research by Park(9) and Buja(10)

conducted on Korean and Italian societies which show that alcohol consumption will have a detrimental impact only on male groups. The differences in body composition and metabolism between the sexes and the type of alcohol consumed are thought to be the causes of differences in the risk of diabetes mellitus related to alcohol consumption.

The strength of this study is the use of data on a large scale and represent the adult population with central obesity in Indonesia. The questionnaire on cigarette and alcohol consumption was specific and used a visual image of alcoholic beverage packaging to equalize perceptions of the size used by research respondents. The standard unit size for alcoholic drinks is determined based on the type of alcoholic drink and the volume of its packaging. This makes the respondent's bias minimized. Second, this study is the first in Indonesia to explore the prevalence of diabetes mellitus in a population with central obesity and its relationship to smoking and alcohol consumption in the adult population.

However, the weakness of this study comes from the cross-sectional design used. Further studies with cohort designs are needed to investigate the differences in the effects of smoking and alcohol consumption in people with central obesity, especially in the female group. Furthermore, the researchers did not include other confounding variables such as co-morbidities, level of physical activity, consumption of risky foods.

CONCLUSION

Based on the 2018 Basic Health Research data, this study states that there is an increased risk of diabetes mellitus, especially in women with central obesity. The results also suggest that alcohol consumption by people with central obesity has an interaction with gender in an increased risk of diabetes mellitus in women compared to men.

Further longitudinal studies are needed to explore the different effects of smoking and alcohol consumption in people with central obesity. Community-based health education programs need to be developed for various age groups, especially elderly people with central obesity, as well as increased physical activity even though they are not working and do not have adequate formal education.

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