Available online: http://journal.ipb.ac.id/index.php/jgizipangan
Accredited based on DGHE, Republic of Indonesia No.12/M/Kp/II/2015
ISSN 1978-1059 EISSN 2407-0920

J. Gizi Pangan, July 2018, 13(2):55-62
DOI: 10.25182/jgp.2018.13.2.55-62

Obesity Risk Factors among 25-65 Years Old Adults in Bogor City, Indonesia: A Prospective Cohort Study

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ABSTRACT

This research was aimed to identify the obesity risk factors in adults aged 25-65 years old in 2011-2014. The study used secondary data from "Cohort study on risk factors of non-communicable diseases" that was collected for two years in 2011-2013 and 2012-2014. The research was designed as a prospective cohort study. The number of subjects was 1006, consisted of 364 men and 642 women. Results showed a 25% prevalence of obese (BMI≥25 kg/m^2). Multivariate Cox regression analysis showed the risk factors of obesity in adults aged 25-65 years old were gender, smoking habit, consumption of fatty foods, and duration of smoking habit. During the two years of observation, obesity developed faster in female subjects compared to male subjects, after adjusted to smoking habit, fat intake, and interaction between smoking habit and time. The risk of obesity in adults can be reduced by not starting smoking at early age and reducing consumption of fatty foods.

Keywords: adults, obesity, risk factors

INTRODUCTION

Obesity has reached the epidemic proportion globally with a prevalence of almost doubled since 1980 (WHO 2013). Low *et al*. (2009) reported the increasing prevalence of overweight and obese in developing and developed countries. In Indonesia, the prevalence of overweight and obese shows an increase every year. The prevalence of obese (BMI>25 kg/m²) among adults (15 years old and above) based on the Basic Health Research 2007 was 13.9% in men and 23.8% in women (Depkes RI 2008). Further analisis on *Riskesdas*' data showed the prevalence of overweight among adult females aged 19-55 years old was 29.4 % (Diana *et al*. 2013). Data from *Riskesdas* 2013 showed the prevalence of obese (BMI>25 kg/m²) among adult males (>18 years old) was 19.7% and 32.9% for adult females (Kemenkes 2013). Moreover, analysis on data of *Riskesdas* 2013 showed that within the age group of 25-65 years old, the prevalence of overweight and obese was 26.1% and 7.2%, respectively (Sudikno *et al*. 2015). Many studies have shown the relationship between obesity and several diseases. Overweight and obesity have been proven to be related with some conditions such as diabetes, cardiovascular diseases, dislipidemia, hypertension, metabolic syndrome, inflammation, thrombosis, certain cancers, and life-span expectation (Peeters *et al*. 2003; Jafar *et al*. 2006; Lestari & Siswanto 2007; Despre´s *et al*. 2008; Mokdad *et al*. 2003; Lee 2009; Marliyati *et al*. 2010; Zalesin *et al*. 2011; Kurukulasuriya *et al*. 2011; Franssen *et al*. 2011; Schmandt *et al*. 2011; Saleh 2015; Sihombing *et al*. 2015).

Obesity is linked to high-calorie food intake, high intake of fatty meat and oily foods, and high consumption of alcohols combined with low physical activity (Lokuruka 2013). Studies have shown the risk factors for obesity are gender, age, occupation, education level, economic status, marital status, urban living area, smoking habit, consumption of fatty food, consumption of sweet food, and level physical activity (Hou *et al*. 2008; Sugianti *et al*. 2009; Oanh *et al*. 2009; Shayo & Mugusi 2011; Mir Islam & Rasooly 2013; Gbary *et al*. 2014; Sudikno *et al*. 2015).

A cohort study on risk factors of non-communicable diseases in 2011-2014 carried out by the Center of Technology for Public Health Intervention, National Institute of Health Research and Development at Bogor Tengah district, Bogor city, West Java province provided data on obesity and its risk factors. In the preliminary study, an analysis has been performed on obesity parameters (body mass index [BMI]) using the lipid profile with cross-sectional design. The initial part of the study was performed with cross-sectional design on 4,554 subjects aged 25-65 years old and it showed that the prevalence of overweight (BMI=25.0-29.9 kg/m^2) in men and women was 24.9% and 37.2%, respectively. Meanwhile, the

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prevalence of obese (BMI ≥ 30 kg/m^2) in men and women was 6.3% and 16.8%, respectively (Sudikno *et al*. 2017). A longitudinal study by Riyadina *et al*. (2017) showed the prevalence of obesity among 888 post-menopause women aged 44-64 years old was 57.2%. The main determinants for obesity in post-menopause women were sufficiency of carbohydrate intake, abnormal triglycerides, lack of physical activity, sufficiency of protein intake, and family history of obesity. The current study was aimed to determine the risk factors for obesity in adults aged 25-65 years old using cohort design from 2011 to 2014.

METHODS

Design, location, and time

The current study used the secondary data from "Cohort Study on Risk Factors of Non-Communicable Diseases (RFNCD)" that was collected for 2 years: 2011-2013 and 2012-2014 by the Center of Research for Public Health Intervention, National Institute of Health Research and Development, the Ministry of Health Indonesia, in 5 sub-districts from 11 administrative villages in Bogor Tengah district, Bogor City, which were Kebon Kalapa, Babakan Pasar, Babakan, Ciwaringain and Panaragan. The research was designed as a prospective cohort study.

Sampling

The population used in the study was all household members aged 25-65 years old residing in the study location. Samples were all members of the households aged 25-65 years old with the criteria of permanent residents in the research location (permanent residency was proven by identity card), independent, no physical disabilities, non-pregnant female respondents, normal BMI (18.5-24.9 kg/m^2) (WHO 2000) and had no non-communicable diseases (hypertension, diabetes mellitus, cancer, stroke, chronic obstructive lung disease) at the beginning of the study, signed on the informed consent form, and duly-filled the data forms. The exclusive criteria were pregnant women and subjects with non-communicable diseases and abnormal BMI at the beginning of the study. Based on two years of observation (2011-2013 and 2012-2014), 1,006 subjects who fulfilled the inclusive criteria were selected to be analyzed. The number of subjects was considered sufficient based on the calculation, which resulted in 892 as the sample size (Lemeshow 1997).

Data collection

The data collected included the risk factors and event (obesity) that appeared during the two years of observation (2011-2013 and 2012-2014) and collected in 7 sampling times. The gap between each sampling time was three months. The baseline (0) was the initial data of the study (2011 and 2013). The risk factors that were analyzed consisted of gender, marital status, age, level of education, occupation, stress level, smoking habit, physical activity, dietary pattern (meat, offal, food cooked with coconut milk, fried foods, noodles, fruits, and vegetables), intake of sugar, fat and salt, and intake of energy, protein, and carbohydrate). The risk factors of obesity that were analyzed were those existed at the beginning of the study and not the dynamic risk factors.

Sociodemographic data collection on smoking habit and physical activity was performed using a questionnaire that was developed specially for the cohort study on risk factors of non-communicable diseases in Indonesia, which was adopted from "The WHO STEPS Instrument for Non Communicable Diseases Surveillance" (Riyadina *et al*. 2012). Assessment of the physical activity was based on the composite calculation of the type and duration of the activity (days per week and minutes per day), including sports. Heavy activities or sports were rated 8 times, medium activity or sports were rated 4 times, and light activity or sports were rated 2 times. Subjects were categorized as lacking in physical activity if the total activity was less than 600 MET (metabolic equivalent) in a week (WHO 2011). The category of education was based on the highest level of education of the subjects, which were categorized into two categories: "low" if the subject never had any formal education or went to middle school and "high" if the subject graduated from the high school or higher. Subjects were categorized as having emotional disturbance (under stressed) if they experienced at least 6 out of 20 symptoms listed in the SRQ (Self Reporting Questionnaire) (Riyadina *et al*. 2012).

Measurement of body height was performed using microtoise that was modified and made from paper carton with the capacity of 200 cm and accuracy of 0.1 cm. Body weight measurement was carried out using digital balance (brand: AND) with the capacity of 150 kg and accuracy of 0.01 kg. Body mass index (BMI) was the ratio between body weight and squared body height (kg/m^2), consisted of normal (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (≥30 kg/m^2) (WHO 2000).

Data collection on food consumption was carried out through food recall interview (1x24 h), while dietary pattern was collected through food frequency questionnaire (FFQ) for the previous week. To estimate the amount/portion of food and drink consumed by the subjects, food models were used as tool and food codes was utilized to help data entry.

Next, nutrient content was calculated using the software Nutrisoft, developed by *Pusat Teknologi Terapan Kesehatan dan Epidemiologi Klinik*, *Balitbangkes* (The Centre for Applied Health Technology and Clinical Epidemiology, National Institute of Health Research and Development). Grouping of nutrients (energy and protein) was based on the adequacy of nutrient intake (*Angka Kecukupan Gizi* (AKG)) (Kemenkes 2013). Energy intake was categorized into two: deficit ((<70% AKG) and sufficient ((≥70% AKG). Protein intake was categorized into two: deficit (<80% AKG) and sufficient (≥80% AKG).

Sufficiency of carbohydrate intake relies on the adequacy of total energy intake based on age and gender, after being subtracted with the adequate intake of protein and fat (Hardinsyah *et al*. 2012), which then was divided into two categories: deficit (<100% AKG) and sufficient (≥100% AKG). Consumption of noodles, meat, offal, foods cooked with coconut milk, fried foods, and vegetables and fruits, was categorized into three groups: never, 1-6 times/week, and ≥7 times/week. Intake of salt, sugar, and fat was based on the Decree of Minister of Health No. 30 in 2013 on labeling of sugar, salt, and fat and health messages on processed food and ready-to-eat-food (Kemenkes 2013). Sugar intake was categorized into two groups: >50 g/day and ≤50 g/day, while salt intake was grouped as: >200 mg/day and ≤2000 mg/day, and fat intake was divided into two: >60 g/day and ≤60 g/day.

Data analysis

Data that were analyzed were the risk factors and prevalence of obesity that developed during the two years of observation (2011-2013 and 2012-2014). Data was collected seven times. The limiting criteria was the subject's condition that was not obese at the pre-determined timeframe. Obese survival rate was calculated using life-table survival analysis. This step of analysis was performed before multivariate analysis. Variables were included in the multivariate analysis if the p value from bivariate analysis was <0.25 (Hosmer & Lemeshow 2000).

The analysis used was time-dependent Cox regression. If the variables had interaction with p value <0.05, then the interaction was included in the multivariate model and further analyzed with Cox regression with reduced model (time-dependant Cox regression). If the assumption of proportional hazard was fulfilled (p>0.05), then Cox proportional hazard model was developed with multivariate regression analysis (time-dependant Cox regression) to determine the risk factors that contributed to obesity by using prediction model and Enter method.

RESULTS AND DISCUSSION

Table 1 shows that during two years of observation, there were 251 cases (25%) of obesity (BMI≥25 kg/m^2) in subjects previously classified as having normal BMI. The trend was doubled in female subjects (63.5%) as compared to the male subjects (36.2%). The age group with the highest case of obesity was 35-44 years old (32.1%) and 59% of the cases were found in the category of low education level. In terms of occupation, most cases of obesity occurred in the group of domestic workers (launderer, cook, baby sitter, etc.), which was 34.9%. Interestingly, there were 6.5% of the subjects who were unemployed. As much as 26.1% of the subjects were under stress. From the marital status, it was found that most subjects were married (84.9%). Physical activity of the subjects were mostly in the category of sufficient (89.1%). Meanwhile, in terms of smoking habit, there were 36.6% of the subjects who were active smokers and only 13% were non-smokers (Table 1).

Most subjects had sufficient energy intake (79%) and protein intake (55.5%). In contrast, most of the subjects were deficit in terms of carbohydrate intake (90.1%). For dietary pattern, only small percentage (2.2%) of the subjects who never consumed noodles, while offal was consumed ≥ 7 times/week for only 1.9% (Table 1).

Table 2 shows that the variables that were included in the multivariate analysis (p<0.25) were gender, age, occupation, level of stress, marital status, physical activity, smoking habit, dietary pattern (meat, offal, fried snacks, and fruits and vegetables), and fat intake.

In the next step, each variable of risk factor was analyzed against time (t). Results of the analysis showed that there were interactions between occupation and smoking habit with obesity. This finding showed that the assumption of proportional hazard was not fulfilled (p<0.05), thus multivariate analysis of time-dependant Cox regression was used (Table 3).

It can be observed in Table 3 that the risk factors for obesity in adults aged 25-65 years old were gender, smoking habit, fat intake, and the interaction between smoking habit and time. Table 3 also shows that the variable that had significant effect on obesity was gender. During two years of observation, there were 84.6% of male subjects who became obese, while among female subject, the percentage was lower (69.6%).

Female subjects had the hazard ratio of 2.44 times of that of the male subjects. In other words, the rate of developing obesity in women was 2.44 times faster than in men during the two years of observation, after adjusted to the vari-

Table 1. Respondent distribution according to socio-demographic characteristics, physical activity, smoking habit, dietary habit, and type of food consumed

Characteristic	n=1006	%	Characteristic	n=1006	%
Obesity status			Carbohydrate intake		
Sensor	755	75.0	Deficit	906	90.1
Event (*obese*)	251	25.0	Sufficient	100	9.9
Gender			Consumption of noodles		
Male	364	36.2	≥ 7 times/week	405	40.3
Female	642	63.8	1-6 times/week	579	57.6
Age (year old)			Never	22	2.2
25-34	234	23.3	Consumption of meat		
35-44	323	32.1	Never	176	17.5
45-54	305	30.3	1-6 times/week	528	52.5
55-65	144	14.3	≥ 7 times/week	302	30.0
Level of education			Consumption of offal		
Low	594	59.0	Never	832	82.7
High	412	41.0	1-6 times/week	155	15.4
Occupation			≥ 7 times/week	19	1.9
Labor	133	13.2	Consumption of eggs		
Merchants, entrepreneurs	234	23.3	Never	185	18.4
Unemployed	65	6.5	1-6 times/week	560	55.7
Domestic work	351	34.9	≥ 7 times/week	261	25.9
Housewife	120	11.9	Consumption of foods cooked with coconut milk		
Government officials, army, police	103	10.2	Never	463	46.0
Level of stress			1-6 times/week	433	43.0
No	743	73.9	≥ 7 times/week	110	11.0
Yes	263	26.1	Consumption of fried snacks		
Marital status			Never	513	51.0
Single	58	5.8	1-6 times/week	356	35.4
Married	854	84.9	≥ 7 times/week	137	13.6
Divorced	94	9.3	Consumption of fruits and vegetables		
Physical activity			≥ 7 times/week	753	74.9
Sufficient	896	89.1	1-6 times/week	132	13.1
Lacking	110	10.9	Never	121	12.0
Smoking habit			Sugar intake		
Active smoker	368	36.6	≤ 50 g/day	992	98.6
Ex-smoker	169	16.8	> 50 g/day	14	1.4
Non-smoker	131	13.0	Salt intake		
Passive smoker	338	33.6	≤ 2000 mg/day	812	80.7
Energy intake			> 2000 mg/day	194	19.3
Deficit	211	21.0	Fat intake		
Sufficient	795	79.0	≤ 60 g/day	674	67.0
Protein intake			> 60 g/day	332	33.0
Deficit	448	44.5			
Sufficient	558	55.5			

Table 2. Hazard ratio based on bivariate Cox regression on risk factors of obesity in adults aged 25-65 years old

Risk factor	p	HR (95%CI)	Risk factor	p	HR (95%CI)
Gender			Carbohydrate intake		
Male		1	Deficit		1
Female	0.000	2.14(1.59-2.59)	Sufficient	0.780	1.06(0.70-1.59)
Age (years old)			Consumption of noodles		
25-34		1	≥ 7 times/week		1
35-44	0.074	1.34(0.97-1.85)	1-6 times/week	0.337	0.68(0.32-1.47)
45-54	0.292	0.82(0.57-1.18)	Never	0.569	0.80(0.37-1.72)
55-65	0.270	0.77(0.49-1.21)	Consumption of meat		
Level of education			Never		1
Low		1	1-6 times/week	0.220	0.81(0.58-1.13)
High	0.098	0.80(0.62-1.04)	≥ 7 times/week	0.929	0.98(0.59-1.40)
Occupation			Consumption of offal		
Labor		1	Never		1
Merchant	0.197	1.41(0.83-2.37)	1-6 times/week	0.710	1.06(0.76-1.49)
Unemployed	0.540	1.25(0.61-2.55)	≥ 7 times/week	0.052	2.01(0.99-4.08)
Domestic worker	0.000	2.42(1.50-3.90)	Consumption of eggs		
Housewife	0.010	2.07(1.19-3.60)	Never		1
Government officials, army, police	0.289	1.39(0.75-2.57)	1-6 times/week	0.507	0.89(0.64-1.24)
Level of stress			≥ 7 times/week	0.811	1.04(0.72-1.50)
No		1	Consumption of foods cooked with coconut milk		
Yes	0.122	1.23(0.94-1.61)	Never		1
Marital status			1-6 times/week	0.679	1.05(0.81-1.37)
Single			≥ 7 times/week	0.809	0.94(0.62-1.45)
Married	0.007	3.38(1.39-8.20)	Consumption of fried snacks		
Divorced	0.119	2.21(0.81-5.99)	Never		1
Physical activity			1-6 times/week	0.411	1.12(0.85-1.48)
Sufficient		1	≥ 7 times/week	0.002	1.71(1.22-2.39)
Lacking	0.099	0.68(0.43-1.07)	Consumption of fruits and vegetables		
Smoking habit			≥ 7 times/week		1
Active smoker		1	1-6 times/week	0.575	1.10(0.77-1.57)
Ex-smoker	0.018	1.54(1.07-2.22)	Never	0.090	0.68(0.43-1.06)
Non-smoker	0.244	1.28(0.84-1.94)	Sugar intake		
Passive smoker	0.004	1.55(1.15-2.11)	≤ 50 g/day		1
Energy intake			> 50 g/day	0.418	0.56(0.14-2.26)
Deficit		1	Salt intake		
Sufficient	0.753	1.05(0.77-1.42)	≤ 2000 mg/day		1
Protein consumption			> 2000 mg/day	0.353	1.15(0.85-1.56)
Deficit		1	Fat intake		
Sufficient	0.671	1.05(0.82-1.35)	≤ 60 g/day		1
			> 60 g/day	0.034	1.31(1.02-1.69)

ables of smoking habit, fat intake, and interaction between smoking habit and time.

The results of this study was in accordance with the studies in Tanzania (Shayo & Mugusi 2011), Afghanistan (Mir Islam & Rasooly 2012), and West Africa (Sidik & Rampal 2009) that showed higher prevalence of obesity in women than in men. This phenomenon was most probably related to the gender difference in brain response to hunger and satiety (Del Parigi *et al*.

Table 3. Final model of multivariate time-dependent Cox regression analysis on risk factors of obesity in adults aged 25-65 years old*

Risk factors	β	Wald	p	HR	95%CI
Gender					
Male				1	
Female	0.892	23.406	0.000	2.44	1.70-3.50
Smoking habit					
Active smoker				1	
Ex-smoker	0.637	2.984	0.084	1.89	0.91-3.89
Non-smoker	0.259	0.376	0.540	1.29	0.56-2.95
Passive smoker	0.726	5.070	0.024	2.06	1.09-3.89
Fat intake					
≤ 60 g/day				1	
> 60 g/day	0.268	4.249	0.039	1.30	1.01-1.68
Smoking habit*duration					
Active smoker*duration				1	
Ex-smoker*duration	-0.040	2.197	0.138	0.96	0.91-1.01
Non-smoker*duration	-0.048	2.374	0.123	0.95	0.89-1.01
Passive smoker*duration	-0.078	11.083	0.001	0.92	0.88-0.96

(-2 Log Likelihood* = 3418.958)

2002). In their study, Gbary *et al*. (2014) found that the following factors: culture, attitude, and psychosocial were related to obesity in women in West Africa.

Factors affecting puberty were also shown to affect the risk of obesity in women. A longitudinal growth study performed in Finland showed that at the age of 31 years old, the prevalence of obesity in women who reached menarche before they were 11 years old was 15% as compared to 4% in those who had menarche at 15 years old and above (Laitinen *et al*. 2001). Fat accumulation during childhood increased the possibility of early menarche (Freedman *et al*. 2003) and young girls with early sexual maturation had longer positive energy balance (Garn *et al*. 1986). Adipose tissue in the body increases following the age since at older age, the metabolic rate and energy expenditure decrease. Thus, older individuals do not need more calories to maintain their body weight. If the calorie intake remains constant or even increases, then the body weight will increase. Men need more calories to maintain their body weight since they have higher basal metabolism rate than women. In post-menopause women, obesity is the results of the decrease in metabolism rate and changes in ovarian hormones that increases the rate of body fat deposition depending on age and energy expenditure (Poehlman *et al*. 1995).

Simkin-Silverman and Wing (2000) stated that menopause in women correlates with increased body weight and central adiposity and decreased physical activity. This study has shown that smoking habit affected obesity. Subjects who were non-smokers, ex-smokers and passive smokers had the hazard ratio of 1.29, 1.89, and 2.06 times faster than those who were smokers. These results were in accordance to those of Cihangir *et al*. (2004), Sugianti *et al*. (2009), Hou *et al*. (2008), and Sudikno *et al*. (2015) who found the correlation between smoking habit and the prevalence of obesity. Quitting from smoking is usually associated with an increase in body weight and change in metabolism of fat cells that results in increased activity of the enzyme lipoprotein lipase in adipose tissue. Increased activity of lipoprotein lipase usually affects the increase in body weight as a result of quitting from smoking (Owen-Smith & Hannaford 1999; Ferrara *et al*. 2001).The results also showed that fat intake affected the prevalence of obesity. Subjects who consumed fat more than 60 g/day had a hazard ratio of 1.3 times faster than those who consumed ≤60 g/day of fat. According to Bray and Popkin (1998), increased consumption of fat, especially saturated fats, was associated with increased obesity cases. Drewnowski (2007) stated that contribution of sweet and fatty food to obesity showed a physiology mechanism that explained how fat intake had roles in the increase of body fat as the results of high energy density, tasty flavor of fatty food, high metabolic efficiency, weak satiety, and weak physiology regulation between fat and carbohydrate intakes.

There were several limitations in the study (1) food consumption was measured only with 24-h food recall, (2) measurement of dietary pattern was only for the previous week, and (3) the existence of recall bias in measurement of food intake, dietary pattern, physical activity, level of stress, and smoking habit.

CONCLUSION

This study showed that gender, smoking habit, fat intake, and interaction between smoking habit and time affected the prevalence of

obesity in adults aged 25-65 years old. Preventive measures by not smoking at early age and reducing fat intake are expected to lower the risk of obesity in adulthood.

ACKNOWLEDGEMENTS

The authors would like to thank the Head of National Institute of Health Research and Development, Ministry of Health Indonesia, and the team of cohort study for non-communicable diseases.

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