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Dietary T*rans* Fatty Acids Intake and its Relation to Dyslipidemia in a Sample of Adults in Depok City, West Java, Indonesia

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ABSTRACT

Introduction: The Basic Health Research of the Ministry of Health Indonesia in 2008 reported that the single most important cause of death was stroke, in both urban and rural populations. The risk factors underlying the cause of death are associated with hypertension, obesity and dyslipidemia. The purpose of this study was to determine the mean intake of *trans* fatty acids and its relation to dyslipidemia in a sample of Indonesian adults. **Methods:** A cross-sectional study was conducted on a total of 180 adult male and female respondents aged 35-60 years living in rural and urban areas of Depok city, West Java. Dietary intake was assessed by means of 24-hour recall and semi-quantitative FFQ. **Results:** The mean intake of *trans* fatty acids was 0.48% of total calories (urban 0.40% and rural 0.55%). The prevalence of dyslipidemia in the rural and urban subjects were 61.1% and 66.7%, respectively. There was a statistically significant relationship between *trans* fatty acids intake and hypercholesterolemia and hypertriglyceridemia. **Conclusion**: The intake of *trans* fatty acid among the Indonesian adults studied was half the recommended level. The high prevalence of dyslipidemia found indicates the need for intervention to reduce the rising incidence of cardiovascular diseases in Indonesia.

Keywords: Dyslipidemia, *trans* fatty acids intake, Indonesia

INTRODUCTION

In Indonesia, cardiovascular disease (CVD) is a public health problem that has become the single most important cause of death. The National Health Survey (2005) indicate that heart and blood vessel diseases among those aged above 15 years have become the leading causes of death, accounting for 8.4% of all mortality. The results of the survey indicate an increasing trend in mortality and morbidity caused by CVD with the prevalence rates being higher in urban than in rural areas. The Basic Health Research (Ministry of Health Indonesia, 2008) showed that the single most important cause of death for those aged above 15 years is stroke, both in the urban and rural populations. Most of these risk factors are closely linked to dietary factors.

Smoking, hypertension and dyslipidemia are the high risk factors contributing to the occurrence of CVD. Dyslipidemia is characterised by an increase in total cholesterol, Low Density Lipoprotein cholesterol (LDL-C), triglycerides and low levels of High Density Lipoprotein cholesterol (HDL-C) in blood (Lichtenstein *et al.*, 2006). One of the risk factors of dyslipidemia is the high consumption of

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atherogenic food. The high intake of saturated fat and *trans* fat will be one of the causes of CVD in the future.

In Indonesia, available data indicate that fat consumption in the urban and rural communities is 21.96% and 18.08% of calories, respectively. Based on average consumption of fat per capita/day, fat consumption in the urban and rural areas that is plant derived is 82.25% and 88.55% of total fat, respectively (Central Bureau of Statistics, 2002). Although fat consumption is still low and dominated by vegetable oil, the proportion of dyslipidemia and cases of heart disease show an increasing trend (National Health Survey, 2005).

Sartika (2011) concluded that *trans* fatty acids from fried foods increased triglycerides and the ratio of total cholesterol/HDL-C. Clinical studies by Judd *et al*. (2002) found that *trans* fatty acids increase total blood cholesterol and LDL-C levels and decrease HDL-C levels. The influence of *trans* fatty acids is worse than the negative effects of saturated fatty acids and cholesterol. Mensink *et al.* (2003) stated that total cholesterol and LDL-C increases simultaneously with an increase in trans-fatty acid intake ($p<0.0001$).

A prospective cohort study by Sartika (2011) concluded that the mean intake of *trans* fat in a sample of Indonesian workers is 0.48% of calories. Research on *trans* fat intake on the urban and rural population in Indonesia has never been done. It is suspected that dietary *trans* fat in the rural population might be higher than in the urban population. The purpose of this study is to determine the mean intake of *trans* fatty acids in the urban and rural populations and its relation to dyslipidemia.

METHODS

Study design

Depok is one the fast growing cities in Indonesia. Depok is a city of varied characteristics. Part of it is urban and includes both exclusive residential areas such as real estate and slumps while there are also educational, industrial and trading areas. The other part is the rural area which includes villages, farms and poultry rearing areas. The National Health Survey (2005), showed that in the rural areas, the majority of households are engaged in agricultural activities, while the proportion of farmers in the urban areas is only 25%. As the closest city from Jakarta (the capital city), Depok is very responsive to physical and social problems resulting from a rapid shift from traditional to a modern lifestyle, including non communicable diseases problems.

Data for this cross-sectional study on adults aged 35-60 years living in rural and urban areas in Depok city, West Java were collected bya multistage sampling method. Sub-districts involved were selected based on urban and rural characteristics. Based on the criteria, Sukmajaya and Sawangan were selected as the two eligible villages with five block village units (RWs) being chosen due to reasons of Probability Proportionate to Size (PPS) from each village. Using a simple random sampling method, subjects from 10 RWs were listed and selected.

Based on sample size calculations (hypothesis tests for two population proportions), the required sample size was found to be 200 respondents. Of the 200 respondents, 180 met the inclusion criteria and were eligible for the study. The inclusion criteria were that they had lived in the selected area for at least one year, whereas the exclusion criteria were (i) being pregnant, (ii) using the pill, injection or implant contraceptives, (iii) suffering from diabetes mellitus and other chronic diseases, and (iv) those who were not willing to participate in the study.

Permission and other administrative requirements for conducting the study were obtained from relevant institutions. Ethical clearance was obtained from the Ethics Committee of the Faculty of Public Health at the University of Indonesia. Prior to the

study, a signed informed consent form for voluntary participation was received from the respondents. All information obtained from the respondents was considered as confidential.

Data collection

Data were collected by the researcher and two trained nutritionists through individual interviews using a standardised questionnaire. The subjects who agreed to participate received a general questionnaire and a 24-hour recall/semi-quantitative food questionnaire. The general questionnaire asked questions on socio-demographic variables, lifestyle factors and the family history of diseases. Blood samples were collected to assess lipid profile, that is, total cholesterol, LDL-C, HDL-C and triglycerides. Blood was collected from each respondent in the morning after a fasting period 10-12 h. Blood samples were taken by three laboratory analysts and were analysed at the Prodia laboratory in Depok in accordance with laboratory-based protocols (ISO-15189). Blood lipid profile was determined by a photometer 'TRX 7010'.

The main independent variable was *trans* fatty acids intake. The dependent variable was dyslipidemia. Dyslipidemia is the elevation of plasma cholesterol, triglycerides, or both, or a low HDL-C level (Lichtenstein *et al*., 2006). The blood results were classified as follows: cholesterol level of >200 mg/dl was considered as 'hypercholesterolemia'; >130 mg/dl as LDL-C 'high'; >160 mg/dl as 'hypertriglyceridemia'; and <40 mg/dl as HDL-C 'low' (Third Report of the National Cholesterol Education Program, 2001).

Educational level, measured using a standardised questionnaire, was classified into two categories: low (< 9 years of schooling) and high (> 9 years of schooling). Nutrition and health knowledge consisted of the impact of fried food on health, sources of fat and knowledge on preventive factors of heart diseases. The scores ranged from 0-10; scores from 0-5 (below the mean) were categorised as 'poor' and scores from 5-10 (above the mean) were categorised as 'good'.

Questions seeking information on familial diseases required a 'yes' or 'no' (Lichtenstein *et al.*, 2006). The exercise habit was classified into regular and irregular. Regular exercises were considered as exercises at home and or the office continuously and rhythmically 3-7 times/week, of 30-60 min duration (Varady & Jones, 2005). Smoking habit was classified into 'current smoker', 'never smoker' and 'former smoker'. The former smokers in this study were subjects who had previously smoked and had stopped smoking for more than a year (Houterman *et al*., 2001).

Dietary intake was assessed using a 24-hour recall questionnaire to estimate total intake of nutrients including *trans* fatty acid and a semi-quantitative food frequency questionnaire to measure usual intake per day, per week, per month, per year or never. The nutrient intake was quantified for each respondent using an extended version of the Nutrient Calculation Software as the Indonesian food composition database. Total *trans* fatty acid intake was calculated for fried foods, ruminant products and margarine/hydrogenated vegetable oil (HVO) products. The content of trans fatty acid from each food group was quantified using a listing of *trans* fatty acid content in different kinds of food (Sartika, 2011) and the Food Balance Sheet from the US Department of Agriculture (USDA, 2002).

Body Mass Index (BMI) is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). Body weight was measured using an electronic personal weight scale (model SECA 843, Volgel and Halke and Co Germany, with an accuracy of 0.1 kg), while height was determined by a microtoise tape (Xenical Orlistat) with an accuracy of 0.1 cm. BMI of the subjects were divided into 4 groups: less (<18.50 kg/m^2), normal (18.50-24.99 kg/m^2), overweight (25.00-27.00 kg/m^2) and obese (> 27 kg/m^2) (Ministry of Health, 2003).

Data analysis

Descriptive data analysis was undertaken to determine the proportion of categorical data and mean values of continuous data (univariate analysis). Chi-square test and independent-samples *T*-test with a significance level of 0.05% was applied to identify correlations between two variables (bivariate analysis). All analyses were conducted with STATA 9.1.

RESULTS

The mean age of respondents was 46.36 years, with a range age of 35.3 to 59.6 years. There were an equal mean of age in both areas. The proportion of females in urban areas was higher than in rural areas. The results showed significantly more people with less educational level (< 9 years of schooling) in rural than in urban areas (Table 1). In line with the level education of respondents, the proportion of respondents who had 'good' knowledge of nutrition and health was significantly higher in urban than in rural areas.

Table 1 shows that there were significant differences between respondents who had a family history of coronary heart disease (CHD) in urban and rural areas. The proportion with a family history of CHD was higher in urban than in the rural population. In this survey, the majority of respondents in urban areas were 'current' and 'former' smokers (85.6%). The prevalence of 'current' and 'former' smokers was significantly different between urban and rural areas.

Overweight (>25 kg/m^2) is a common problem among the respondents both in urban and rural areas. Overall, the proportion of overweight in urban (57.7%) was higher than in rural areas (32.9%), with a value of p <0.05. The mean of body mass index (BMI) of respondent in urban and rural areas were 26.27 kg/m^2 (min-max 17-44 kg/m^2) and 23.42 kg/m^2 (min-max 14-43 kg/m^2), respectively. Most of the respondents did not exercise regularly both in urban and rural areas.

Table 1. Background characteristics of respondents in urban and rural areas

Characteristics	*Urban areas (n=90)*	*Rural areas (n=90)*	*p-value (95% CI)*
Age (mean ± SD, year)	46.6±9.9	46.2±8.7	0.79 (-2.52;3.32)
Sex: female (%)	57.8	43.3	0.07 (0.31;1.01)
Educational level:			
>9 years of schooling (%)	86.7	20.0	0.00* (11.71;57.72)
Level of nutrition and health knowledge:			
good (%)	81.1	44.4	0.00* (2.74;10.51)
Family history of CHD (%)	25.6	7.8	0.00* (1.65;10.06)
Smoking habit: never (%)	14.4	38.9	0.00* (1.83;7.78)
BMI: 'overweight' (≥25.00 kg/m^2) (%)	57.7	32.9	0.00* (1.51;5.13)
Exercise habit: irregular (%)	60.0	72.2	0.11 (0.31;1.08)
Total cholesterol (mean±SD, mg/dl)	205.3±40.0	201.8±38.5	0.55 (8.03;15.07)
Triglyceride (mean±SD, mg/dl)	132.7±18.9	145±25.8	0.34 (3.80;13.4)
LDL-C (mean±SD, mg/dl)	128.9±33.7	123.4±30.8	0.26 (4.03;15.00)
HDL-C (mean±SD, mg/dl)	50.1±9.9	49.3±9.4	0.61 (2.11;3.58)

Note:* statistically significant (p<0.05)

Trans *fatty* acid intake

Types of foods containing *trans* fatty acids were divided into three types of food: fried foods, ruminant products and margarine/HVO products. Table 2 shows that the mean of *trans* fatty acid intake for all respondents was 0.48% of total calories, with the min-max value being 0.009-2.00% of total calories. The mean of *trans* fatty acid intake in urban and rural areas were 0.40% (min-max 0.02-2.00%) and 0.55% (min-max 0.009-2.00%) of total calories, respectively (p=0.02). In terms of type of fatty acid intake, the rural population consumed more fatty foods rich in *trans* and saturated fatty acid than the urban population and this perhaps may be explained by their consumption of more fried food. The mean intake of animal protein and MUFA were higher in urban than in rural areas while the intake of carbohydrate and PUFA in the rural areas was higher than in the urban areas (Table 2). Most of the respondents in rural areas consumed fried foods (73.4%), whereas in urban areas, they consumed ruminant products (63.3%).

Characteristics of blood lipid profile

Dyslipidemia is an abnormality in lipid metabolism. Table 3 shows that there were significant differences between *trans* fatty acid intake and hypercholesterolemia and hypertriglyceridemia ($p<0.05$). Figure 1 shows that there were no significant differences in proportion of dyslipidemia, LDL-C 'high', hypertriglyceridemia, hypercholesterolemia and HDL-C 'low' in both areas. The proportion of dyslipidemia, LDL-C 'high', hypercholesterolemia and HDL-C 'low' was higher in urban than in rural areas, while the proportion of hypertriglyceridemia was higher in rural areas.

DISCUSSION

This study found that the intake of fat and saturated *fatty* acid in both areas was higher than the recommended dietary allowance. The American Heart Association recommends that fat and saturated fat intake should be less than 30% and 10% of total

Table 2. Mean nutrient intake in urban and rural areas

Intake of nutrients	*Urban areas (n=90)*	*Rural areas (n=90)*	*p-value (95%CI)*
Trans fatty acid (mean ±SD,%of calories)	0.40±0.04	0.55±0.04	0.02* (-0.28;0.22)
Fat (mean ± SD, % of calories)	31.98±1.02	32.01±1.11	0.98 (-3.18;3.11)
SAFA (mean ± SD, % of calories)	14.17±0.62	14.88±0.68	0.46 (-2.63;1.20)
MUFA (mean ± SD, % of calories)	8.45±0.34	6.96±0.29	0.00* (0.55;2.43)
PUFA (mean ± SD, % of calories)	6.75±0.38	8.17±0.35	0.01* (-2.49;-0.33)
Carbohydrate (mean ± SD, grams)	152.22±6.40	186.21±7.41	0.00* (-5.52;1.35)
Animal protein (mean ± SD, grams)	23.16±1.47	17.88±1.61	0.02* (0.74;9.82)
Food consumption habit of:			
Fried food: ≥5servings/week (%)	26.6	73.4	0.00* (3.10;11.43)
Ruminant products:			
1-4servings/week (%)	63.3	36.7	0.00* (1.63;5.47)
Margarine: 1-4servings/week (%)	57.8	42.2	0.87 (0.59;2.05)

*Note:** statistically significant ($p<0.05$)

Table 3. Mean intake of *trans* fatty acids in blood lipid profiles

Blood lipid profiles	*n*	*Mean (% of calories)*	*SD*	*p-value*	*95%CI*
Dyslipidemia	115	0.51	0.05	0.23	-0.22;0.05
Normal	65	0.42	0.04		
LDL-C 'high'	75	0.54	0.04	0.09	-0.02;0.24
Normal	105	0.43	0.04		
HDL-C 'low'	30	0.51	0.05	0.65	-0.13;0.21
Normal	150	0.47	0.04		
Hypercholesterolemia	89	0.55	0,04	0.03*	0.02;0.27
Normal	91	0.40	0.03		
Hypertriglyceridemia	49	0.59	0.05	0.04*	0.00;0.30
Normal	131	0.43	0.04		

Note:* statistically significant ($p<0.05$)

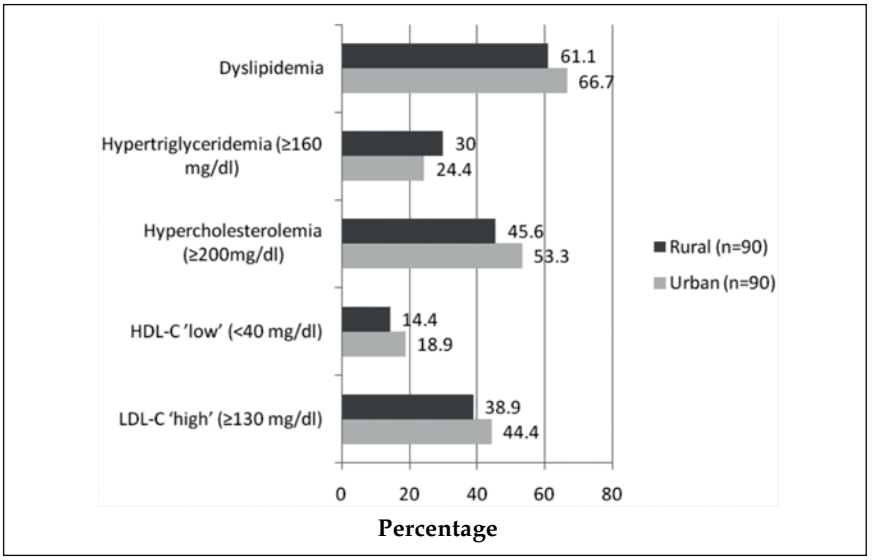

Figure 1. Proportion of respondents based on lipid profiles in urban and rural areas ($p>0.05$)

calories, respectively (Lichtenstein *et al*., 2006). Sartika (2011) concluded that the intake of fat and saturated fat in workers are 31% and 14% of total energy, respectively. Liputo *et al.* (2001) found the consumption of fat and saturated fat in Minangkabau food to be 21.7% and 18.0% of calories.

Trans fatty acids are naturally found in ruminants and other dairy products (milk, cheese). The other sources are in fried foods and margarine/HVO product. The mean of total *trans* fatty acid intake was 0.48% of total energy (0.40% in the urban population and 0.55% in the rural population), with a p value of <0.05. A previous study found *trans* fatty acid intake in a sample of Indonesian workers to be 0.48% (Sartika, 2011), whereas in Western Europe, it is 0.5-2.1% (Hulshof *et al*., 1999), and in the United States, it is 2-3% of calories (Allison *et al*., 1999). The

American Heart Association (AHA) recommends that it should be less than 1% of total calories (Lichtenstein *et al*., 2006). When compared with AHA recommendations, it can be said that *trans* fatty intake in the Indonesian society has reached half of the recommended value. A prospective cohort study by Sartika (2011) concluded that every additional one percent of saturated fatty intake is associated with an increase in *trans* fatty acids amounting to 0.03% of total calories. Although the *trans* fatty acid intake in the urban and rural populations in this study was still relatively low, this value is expected to increase in line with the increase in consumption of saturated fat and could be a risk factor for CHD in later life.

The major source of *trans* fatty acids in the diet are fried food, ruminant products and hydrogenated vegetable oil. This study found that the total *trans* fatty acid intake was significantly higher in rural than in urban areas. Table 2 shows that the consumption habit of fried food was more frequent in rural than in urban areas, in contrast to ruminant products. Sartika (2011) reported that *trans* fatty acid intake from fried food, ruminant products and margarine/HVO are 0.20, 0.09 and 0.06% of total calories, respectively. Fat consumption is substantially related to socio-economic status, and this is perhaps related to the consumption of trendy foods by higher income people living in urban areas.

In Indonesian society, fried food is a favourite for the low- to middle-income households, because it is cheap and easily available along the streets or in public places such as bus stops, stations/terminals, traditional market, schools and other places. Many types of fried foods such as *bakwan*, fried banana, fried cassava, fried sweet potato, fried tofu, fried *mendoan tempeh* are sold using a cart (called a '*gerobak*').

Food habits have a definite influence on the menu and the blood lipid profile is commonly associated strongly with the menu. In an urban society, lifestyle may contribute to several chronic non-communicable diseases. Dietary intake has an important impact on the development of cardiovascular diseases. Urban populations usually eat less rice, and more of bread, milk, butter, cheese, fast food (burgers, steaks, hot dog, pizza) and meat. The rural population tends to eats more of rice, fried food and food preparations with coconut milk *(santan)*. Coconut oil and palm oil are frequently used in Indonesian cooking.

In this cross-sectional study, disease status and nutritional exposure were measured at the same time. The design of this cross-sectional study does not allow for assessing causal associations. The problem is the difficulty of determining whether nutritional exposure is a cause of the disease or that nutritional exposure is affected by the disease process. In our study, we did not undertake an analysis using a multivariate test, so we could not assess causal associations by controlling for intake of other food items. The effects of *trans* fatty acid intake on dyslipidemia could be confounded by the intake of other dietary items.

Table 3 shows that there was a statistically significant relationship between *trans* fatty acids intake and hypercholesterolemia and hypertriglyceridemia. Although not statistically significant, the mean intake of *trans* fatty acid tended to be higher in dyslipidemia, LDL-C 'high' and HDL-C 'low' respondents compared to respondents with a normal condition. Perhaps the small sample size was a limiting factor to assess the relationship between *trans* fatty acids intake and dyslipidemia or the results could have been confounded by the intake of other fatty acids. A prospective cohort study by Sartika (2011) concluded that *trans* fatty acids from fried foods increases triglyceride and the ratio of total cholesterol/HDL-C. Like saturated fatty acids intake, there is a need to be concerned about the metabolic effects of trans fatty acids especially if it is consumed everyday in small quantities.

A research carried out by Oomen *et al.* (2001) concluded that *trans* fatty acids, either

natural or artificial/processed, have a similar negative impact on health. Recent studies have found that the influence of *trans* fatty acids is worse than the negative effects of saturated fatty acids and cholesterol.The difference is that saturated fatty acids do not affect HDL-C (Judd *et al.*, 2002). Motard-Belanger Charest & Grenier (2008) found a significant relationship between increased consumption of *trans* fatty acids, an increase in LDL-C and a decrease in HDL-C. Chardigny *et al.* (2008) reported that the industrial *trans* fatty acid diet lowers HDL-C, LDL-C and triacylglycerol concentrations compared with dairy *trans* fatty acid. Mozaffarian *et al.* (2006) concluded that LDL-C is a known risk factor for heart disease that is affected by the consumption of *trans* fatty acids from industrial sources.

Dyslipidemia is a disorder of lipid metabolism characterised by an increase or decrease in plasma lipid fractions. There is an increasing prevalence of dyslipidemia in Indonesia. The MONICA study in Jakarta showed that the prevalence of dyslipidemia has increased 3% within 5 years (1988-1993) (Rahajeng, 2003).

Sartika (2011) found the prevalence of hypercholesterolemia, LDL-C 'high' and HDL-C 'low' in a sample of Indonesian workers to be 65.2%, 42.1% and 6.3%. Rahajeng (2003) concluded that the prevalence of LDL-C 'high' and HDL-C 'low' in Abadijaya (a village in Depok) were 53.7% and 64.7%, respectively.

Blood cholesterol level is commonly used for early detection of CHD. LDL cholesterol component is a compound of atherogenic LDL, whereas HDL-C is an independent factor that protects against the development of ateroma (Dietschy, 1998).

This study found that the proportion of dyslipidemia, hypercholesterolemia, LDL-C 'high' and HDL-C 'low' were higher in the urban than in the rural populations (Figure 1). If only the type of fatty acid intake is considered, there were no significant differences between intake of saturated fatty acid in urban and rural populations, though it was found that the urban population had a lower trans fat intake than the rural (Table 3). The high proportion of dyslipidemia in the urban population could be attributed to the high proportion of respondents being smokers, being obese and having a family history of CHD (Table 1). Most of these risk factors are closely linked to dietary factors and a sedentary life style. These problems need to be countered as early as possible through a state-sponsored educational programme.

CONCLUSION AND RECOMMENDATIONS

The intake of *trans* fatty acid in the Indonesian society has reached half the recommended value. It is known that *trans* fatty acid intake is related to hypercholesterolemia and hypertriglyceridemia. The high prevalence of dyslipidemia both in urban and rural areas needs particular attention to prevent a higher incidence of CVD. Other studies are recommended to determine *trans* fatty acid intake among diverse ethnic groups in Indonesia.

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