

OVERVIEW OF DIABETES MELLITUS AND ITS RISK FACTORS IN INDONESIA: AN ANALYSIS OF BASIC HEALTH RESEARCH DATA

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Abstract. Diabetes mellitus (DM) is the third cause of death in Indonesia in 2019 and it becomes national and international concern. Analysis of district data of DM which could complement individual data analysis is still limited. This district data analysis will add existing information about the disease at different level. This study aimed to describe DM prevalence in Indonesia as well as the factors associated with it at district level. The study was a cross-sectional study involving descriptive, correlation, and multiple linear regression analysis. This study used secondary data from Basic Health Research Data, Ministry of Health 2007, 2013, and 2018. A set of data, consisting 504 out of 514 districts with total 713,783 samples, included prevalence of DM and ten risk factors. By district, the average prevalence for DM was 1.82%, overweight 13.17%, obesity 20.53%, central obesity 30.10%, sweet food consumption 39.02%, sweet beverage consumption 59.68%, fatty food consumption 32.80%, lack of fruit and vegetable consumption 94.77%, lack of physical activity 33.29%, smoking 28.35%, and hypertension 30.81%. From 2007 to 2018, DM prevalence increased by 1.14%, fatty food consumption 25.29%, and obesity 11.61%. In multivariate analysis, factors that significantly associated with DM prevalence were obesity ($p<0.001$; B 0.041), central obesity ($p<0.001$; B 0.047), sweet food consumption ($p<0.001$; B -0.013), sweet beverage consumption ($p=0.005$; B 0.010), fatty food consumption ($p<0.001$; B 0.014), and smoking ($p<0.001$; B -0.037). Efforts on DM risk factors control, especially for obesity and central obesity, should be strengthened. Future research involving multilevel analysis is needed.

Keywords: diabetes mellitus, risk factors, district, Indonesia

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INTRODUCTION

Diabetes mellitus (DM) is one of the biggest public health problems in Indonesia. This disease became the third highest cause of death in 2019, rose from rank number 10 in 1990, with a rate of 40.98 per 100,000 population and an increase of 128.7% (IHME, n.d.). It becomes national and international concern. DM control has now become part of the Sustainable Development Goals (SDGs) target with the aim of decreasing one-third premature death due to non-communicable disease through prevention and treatment (UN, 2015). In Indonesia, DM control program is also one of the indicators in the minimum service standards for the health sector that must be provided by the District/Municipality Government to prevent people from diabetes mellitus (MOH RI, 2019b).

In order to prevent and control diabetes mellitus, one of the best efforts is to prevent and control its risk factors. There are several factors influencing DM including obesity, smoking, unhealthy diet, lack of physical activity, hypertension, raised blood glucose, and increase in cholesterol (WHO, 2001). Similarly, the Indonesian Association of Endocrinology stated that modifiable risk factors for diabetes were obesity, lack of physical activity, hypertension, dyslipidemia, and unhealthy diet (Indonesian Association of Endocrinology, 2019). Several studies show the same finding, as suggested by Kistianita *et al* (2018) who stated that there was a significant relationship between fruit and vegetable consumption, physical activity and the incidence of Type 2 DM. Another study stated that risk factors for DM include unhealthy diet, lack of physical activity, smoking, hypertension, and obesity (Peters *et al*, 2019). Overweight, obesity, high triglyceride, and hypertension are risk factors for DM in men and women (Zhang *et al*, 2019). Even though risk factors of

DM have been revealed in many studies, but the study involving district prevalence data is still limited. District level data will provide evidence that come from local conditions. This will give additional information to strengthen evidence of the risk factors which were analyzed from aggregate data.

Basic Health Research, a national health survey in Indonesia, is conducted regularly every 5 years. This survey provides health data including disease and risk factors. Prevalence of and its risk factors are among the data given by the survey. The data from Basic Health Research can be used as a source of information to further prevent the disease. To this day, there are limited previous studies that analyze the survey data to find out the correlation between DM and its risk factors at the district level. The association between the risk factors in district level will be an important information to complement the risk factors at individual analysis. This is needed to add existing information about DM and its risk factors at different level. Additionally, the information will be source of information to the district government to develop program of prevention and control for appropriate risk factors of diabetes mellitus. Hence, we conducted this study to describe DM prevalence in Indonesia and the factors associated with it at district level.

MATERIALS AND METHODS

This study was a cross-sectional study. This study used secondary data which was collected from Basic Health Research, Ministry of Health 2007, 2013, and 2018 (MOH RI, 2008; MOH RI, 2014b; MOH RI 2019a). A set of data consisting 504 out of 514 districts (98%) with total 713,783 sample includes DM prevalence and ten risk factors. Variables included in the research were independent variable (DM prevalence) and dependent variables (prevalence of overweight, obesity, central obesity, sweet food consumption, sweet beverage consumption, fatty food consumption, lack of fruit and vegetable consumption, lack of physical activity, smoking, and hypertension).

Diabetes mellitus is defined as people aged 15 years and above diagnosed with such disease (any DM) by medical doctors last year obtained from interview. Overweight is defined as a body with a mass index (BMI) of 25-26.99 kg/m² while obesity is 27 kg/m² and above. Central obesity was categorized by waist circumferences of 90 cm and above for males and 80 cm and above for females. Sweet food consumption is defined as consumption the food containing excessive sugar/carbohydrate 1 time or more a day and sweet beverage consumption is consumption the drinking water containing excessive sugar 1 time or more a day. Fatty food consumption is excessive consumption of fried food 1 time or more per day. Meanwhile, lack of fruit and consumption means lack of 5 portion of fruit or vegetables consumption a day. Lack of physical activity is defined as having less than 30 minutes a day or 150 minutes a week for moderate physical activity. Smoking means active smoking in the last month, while hypertension was measured by blood pressure examination using cut off 140 mmHg for systole or 90 mmHg for diastole.

For data analysis, this study employed descriptive analysis, bivariate analysis, and multivariate analysis. Aggregate data at district level, which had been weighted by population size, was used as analysis unit. Descriptive analysis was performed to reveal the distribution and increase of DM prevalence and determinant variables from 2007 to 2018. Bivariate analysis using Pearson correlation test was performed for data of 2018 to assess the association between prevalence of the risk factors and prevalence of diabetes mellitus. Meanwhile, multivariate analysis using multiple linear regression form data 2018 was performed to calculate the adjusted association between risk factors and diabetes prevalence.

Multiple linear regression analysis was developed through step of bivariate selection, multivariate modelling, and final model development. Bivariate selection was performed by correlation analysis between risk factors and DM prevalence, which risk factors that had p-value less than 0.25 was inputted into full model (Hastono, 2006). Based on bivariate analysis, 9 out of 10 risk factors being included in the full model were prevalence

of overweight obesity, central obesity, sweet food consumption, sweet beverage consumption, fatty food consumption, lack of physical activity, smoking, and hypertension.

The multivariate testing used Enter method. Then, the multivariate modelling was performed by excluding variable from full model that had $p > 0.05$. If the variable did not influence R^2 and B of other variables for 10%, the variables were kept excluded. The variables excluded from final model were overweight, lack of physical activity, and hypertension. In order to justify the fit of the model, all assumptions of multiple linear regression were tested for existence, independence, linearity, homoscedasticity, normality, and collinearity (Hastono, 2006; Kleinbaum, 1998). After testing, all assumptions were complied.

The study was approved by the Research and Community Engagement Ethical Committee Faculty of Public Health Universitas Indonesia No. Ket-438/UN2.F10.D11/PPM.00.02/2022 on 22 June 2022.

RESULTS

Fig 1 shows the prevalence of DM in Indonesia in 2018 by district, which varied across districts. The highest prevalence of DM was found in the Districts of Madiun, East Java (5.33%), Mojokerto, East Java (4.98%) and Jogjakarta City, Jogjakarta (4.79%). Meanwhile, the lowest prevalence of DM was observed in the Districts of Yalimo (Papua), Buru Selatan (Maluku), and Alor (East Nusatenggara) for 0.08%, 0.09%, and 0.09% respectively.

The increase of DM prevalence in Indonesia by district from 2007 to 2018 was shown in Fig 2, which also varied across districts. This revealed that the highest increase in prevalence was discovered in the Districts of Sabang, Aceh (3.22%), Manado, North Sulawesi (3.21%), and Kepulauan Talaud, North Sulawesi (3.17%). Meanwhile, there was decrease in the Districts of Timor Tengah Selatan, East Nusatenggara (1.07%), Belu, East Nusatenggara (0.92%), and Mamberamo Raya, Papua (0.80%).

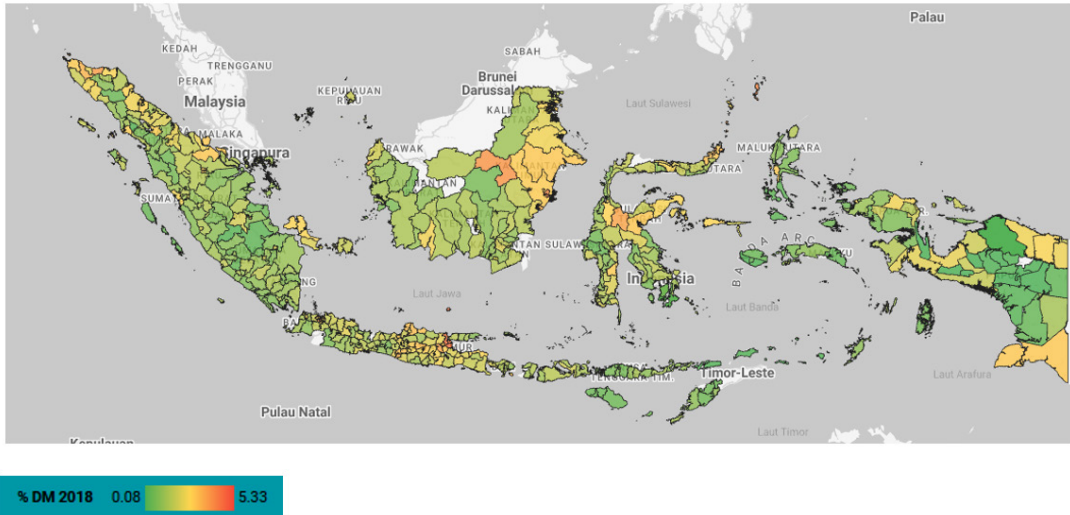


Fig 1 - Prevalence of diabetes mellitus in Indonesia, 2018, by District

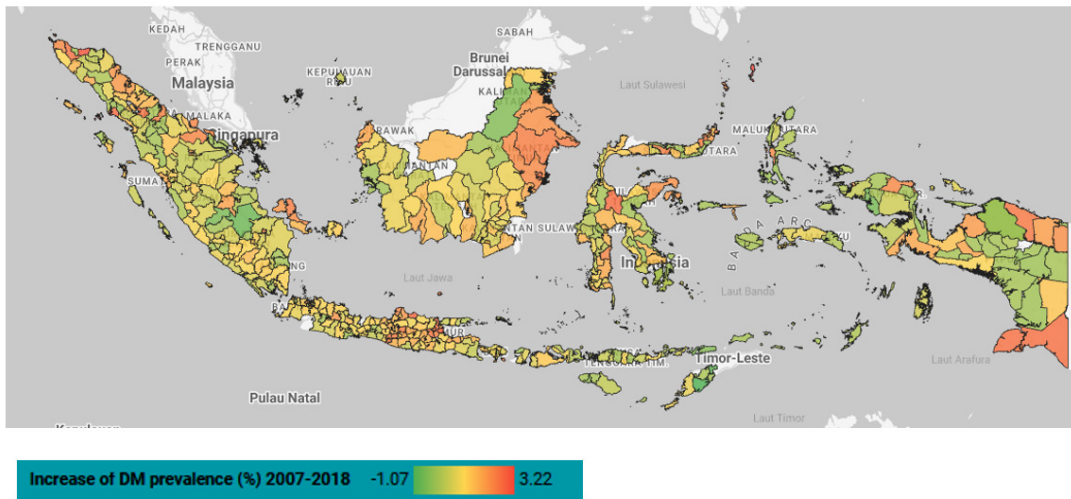


Fig 2 - Percent increase of diabetes mellitus prevalence in Indonesia by district (2007-2018)

Table 1

Percent prevalence of diabetes mellitus and its risk factors in Indonesia, 2018

Variable	Mean	Median	Minimum	Maximum	Standard deviation (SD)
Diabetes mellitus	1.82	1.68	0.08	5.33	0.93
Overweight	13.17	13.34	2.58	22.43	2.61
Obesity	20.53	20.10	3.64	40.85	5.90
Central obesity	30.10	30.38	5.99	49.68	6.98
Sweet food consumption	39.02	39.04	2.53	71.25	11.81
Sweet beverage consumption	59.68	60.97	11.06	88.21	11.91
Fatty food consumption	32.80	31.15	0.28	77.61	17.12
Lack of fruit and vegetable consumption	94.77	96.26	58.98	100.0	5.03
Lack of physical activity	33.29	31.45	10.69	93.06	11.94
Smoking	28.35	28.39	8.04	53.50	4.33
Hypertension	30.81	31.06	5.77	51.99	8.20

Table 1 shows the average (mean) DM prevalence and its risk factors by district. The average of DM prevalence was 1.82%, overweight was 13.17%, obesity was 20.53%, central obesity was 30.10%, sweet food consumption was 39.02%, sweet beverage consumption was 59.68%, fatty food consumption was 32.80%, lack of fruit and vegetable consumption was 94.77%, lack of physical activity was 33.29%, smoking was 28.35%, and hypertension was 30.81%.

Table 2 shows the increase in DM prevalence and its risk factors from 2007-2018. DM prevalence increased by 1.14%. Meanwhile, for the risk factors, the biggest increase was seen in the prevalence fatty food consumption (25.29%), obesity (11.61%), and central obesity (10.78%). Interestingly, the prevalence of lack of physical activity decreased by 14.17%.

Table 2

Increase and decrease of the percent prevalence of diabetes mellitus and its risk factors in Indonesia, 2007-2018

Variable	Mean	Median	Minimum	Maximum	Standard deviation (SD)
Diabetes mellitus	1.14	1.08	-1.07	3.22	0.73
Overweight	4.90	4.82	-3.55	11.44	2.32
Obesity	11.61	11.53	-1.64	24.93	4.26
Central obesity	10.78	12.78	-67.96	30.01	12.86
Fatty food consumption	25.29	24.25	-24.52	73.51	15.20
Lack of fruit and vegetable consumption	1.36	0.61	-24.92	25.92	7.00
Lack of physical activity	-14.17	-13.48	-71.43	52.35	16.34
Smoking	-1.05	-0.96	-20.32	7.87	3.76
Hypertension	3.11	2.50	-23.49	40.09	9.87

Note: – indicates a decrease in percent prevalence.

Table 3 shows the factors that were significantly correlated with the prevalence of diabetes mellitus from bivariate analysis, they are: overweight ($p < 0.001$; r 0.439), obesity ($p < 0.001$; r 0.589), central obesity ($p < 0.001$; r 0.595), sweet food consumption ($p = 0.006$; r 0.122), sweet beverage consumption ($p < 0.001$; r 0.175), fatty food consumption ($p < 0.001$; r 0.359), smoking ($p < 0.001$; r -0.156), and hypertension ($p < 0.001$; r 0.167). Obesity and central obesity had strong positive correlation with DM prevalence. It means the higher prevalence of obesity and central obesity, the higher prevalence of DM. Meanwhile, lack of fruit and vegetable consumption and lack of physical activity were not correlated with DM prevalence.

Multivariate analysis (multiple linear regression) result shows that in the final model, there were six variables remained associated with DM

Table 3
Correlation between selected risk factors with diabetes mellitus prevalence

Variable	r	p-value
Overweight	0.439	<0.001
Obesity	0.589	<0.001
Central obesity	0.595	<0.001
Sweet food consumption	0.122	0.006
Sweet beverage consumption	0.175	<0.001
Fatty food consumption	0.359	<0.001
Lack of fruit and vegetable consumption	-0.050	0.259
Lack of physical activity	0.053	0.234
Smoking	-0.156	<0.001
Hypertension	0.167	<0.001

Note: r represents the strength of association (correlation) between each risk factor prevalence and diabetes mellitus prevalence. When $r \leq 0.25$, it indicates weak correlation, $r 0.26-0.50$ indicates medium correlation, $r 0.51-0.75$ indicates strong correlation, and $r \geq 0.76$ indicates very strong correlation. Positive-negative value indicate the direction of the correlation. Positive value means the higher prevalence of risk factors the higher prevalence of DM while negative value describes higher risk factor prevalence the lower prevalence of diabetes mellitus.

prevalence ($R^2 = 0.484$ $p < 0.001$). The variables associated were obesity ($p < 0.001$; B 0.041), central obesity ($p < 0.001$; B 0.047), sweet food consumption ($p < 0.001$; B -0.013), sweet beverage consumption ($p = 0.005$; B 0.010), fatty food consumption ($p < 0.001$; B 0.014), and smoking ($p < 0.001$; B -0.037). Obesity and central obesity had the biggest contribution on DM prevalence in the multivariable analysis (Table 4).

Table 4

Influence of risk factors to diabetes mellitus prevalence based on multivariate linear regression modeling

Variable	Beta (B)	<i>p</i> -value	R ²
Constant	0.040		0.484
Obesity	0.041	<0.001	
Central obesity	0.047	<0.001	
Sweet food consumption	-0.013	<0.001	
Sweet beverage consumption	0.010	0.005	
Fatty food consumption	0.014	<0.001	
Smoking	-0.037	<0.001	

Note: Beta (B) means how big the risk factor influencing the prevalence of diabetes mellitus in multivariate analysis, while positive value indicates positive influence and negative value indicates negative influence. R² represents the number of combination influences of the risk factors to the prevalence of diabetes mellitus. R² <0.33 indicates weak influence, R² 0.33-0.66 indicates moderate influence, and R² ≥0.67 indicates strong influence.

DISCUSSION

The findings of this study show that the average of DM prevalence was 1.82% per district. The prevalence of overweight was 13.17% and obesity was 20.53%. The prevalence of central obesity, fatty food consumption, lack of physical activity, smoking, and hypertension, were around 30% per district. Meanwhile, the prevalence of sweet food consumption 39%, sweet beverage consumption 59%, and lack of physical activity was more than 94%. This indicated that the prevalence of diabetes based on the interview conducted was lower than the prevalence based on blood measurement in Indonesia of 8.5% (MOH RI, 2019a) and the estimate based on secondary data from the Institute of Health Metric and Evaluation (IHME) of 3.98% (IHME, n.d.). This difference also indicates that the DM prevalence from interview (diagnosed

DM) is lower than that based on blood glucose measurement (undiagnosed DM). Meanwhile, the risk factors at the district level were quite high, which need to be controlled. As DM health services and screening of its risk factors has become part of the minimum health service standard at the district level, the district governments should strengthen their effort to prevent and control the risk factors in their areas.

The other findings of this study revealed that overweight, obesity, central obesity, and fatty food consumption had medium positive correlation with diabetes mellitus. In multivariate analysis, the factors associated with DM prevalence in Indonesia ($R^2 = 0.484$) were obesity, central obesity, sweet food consumption, sweet beverage consumption, fatty food consumption, and smoking. This indicate that these 6 risk factors contribute to the prevalence of diabetes in Indonesia in district level.

This result is in line with prediction model of diabetes from Meng *et al* (2013) which employed BMI, smoking, alcohol consumption, tea consumption, coffee consumption, physical activity, sleep stress, meat consumption, fish consumption, vegetable consumption. Such results were in line with other studies, such as the study of Peters *et al* (2019) who stated that risk factors for DM are hypertension and obesity. The studies of Kurniawaty and Yanita (2016) and Isnaini and Ratnasari (2018) showed that obesity was associated with diabetes. Other studies showed central obesity and age ≥ 50 years may increase the risk of Type 2 DM (Trisnawati *et al*, 2013). Factors related to Type 2 DM are blood pressure and cholesterol levels (Trisnawati and Setyorogo, 2013). Overweight/obesity constitutes a risk factor for diabetes mellitus (Olesen *et al*, 2020). There is an independent association between DM prevalence rates and per capita sugar consumption both worldwide and with special regard to the Asian region (Weeratunga *et al*, 2014). Study in China shows that there is a relationship between abdominal volume index (AVI) or abdominal adiposity and diabetes mellitus (Hu *et al*, 2022).

The control of overweight, obesity, and central obesity risk factors should be prioritized. Obesity and central obesity should be prevented through diet and physical activity (Indonesian Association of Endocrinology,

2019). Similarly, a study conducted by Zhang *et al* (2019) showed that overweight and obesity are risk factors for diabetes among males and females. Participating in active physical activity and maintaining body mass index have been shown to be able to lower the risk of DM in adults (Steyn *et al*, 2004). Moreover, a quasi-experimental study by Pamungkas *et al* (2015) showed that dietary behavior and physical activity are associated with fasting blood sugar levels. Diet and physical activity promotion program is cost-effective and the cost can be lowered further when presented in community or primary care settings (Li *et al*, 2015).

DM may lead to many complications such as heart and blood vessel disease, kidney failure, visual impairment, impotence, gangrene, and others (Indonesian Association of Endocrinology, 2019). Thus, the complications need to be prevented, especially using secondary efforts through blood sugar screening and monitoring as well as tertiary efforts with comprehensive treatment (Indonesian Association of Endocrinology, 2019). The roles of Pandu PTM (Integrated Services for NCD) and Prolanis (Chronic Disease Management), the programs of non-communicable disease (NCD) control in primary health centers may be scaled up and involve community participation. The services will increase enabling factors (health services). Meanwhile, community participation will give themselves the motivation to detect and control risk factors and DM early, which is related to predisposing factors (knowledge, attitudes) (Green *et al*, 1980). The Interhealth Program, which is the intervention of the main modifiable risk factors of NCD in a community through a community approach integrated with health promotion and services (Nissinen *et al*, 2001), could be developed to prevent and control diabetes mellitus.

This study has several limitations, such as the fact that the data analyzed was aggregate data at the district level which can cause ecological bias. This may lead to different conclusion between result of this research which is based on aggregate data compared to individual data analysis. But, the variables included in this study are limited factors that substantively based on theories to minimize the bias. The prevalence of diabetes and risk factors was based on an interview, meaning that the quality of data depends

on the interviewer's ability to ask, which may lead to information bias. But, the interviewer of Basic Health Research had been standardized through specific training so the bias can be minimized.

Based on the result of this study, it is recommended to strengthen the efforts on risk factors prevention and control, especially for obesity and central obesity. The campaign of the healthy living community movement (GERMAS) needs to be expanded and improved. In addition, regulation concerning sugar, salt, and fat contained in the Ministry of Health's Decrees (MOH RI, 2013; MOH RI, 2015) also needs to be implemented. Early detection and monitoring of NCD risk factors through Integrated NCD Post (Posbindu) should be expanded and strengthened. Posbindu is a form of independent and continuous community participation in the early detection, monitoring, and early follow-up of NCD risk factors (MOH RI, 2014a). For cases of DM, Pandu PTM and Prolanis) programs at primary health centers should be enhanced (MOH RI, 2016). Result of the study can be used by district government to improve DM prevention and control program. Program of healthy diet and physical activity to decrease obesity and central obesity should be expanded and strengthened, especially in the district which has higher prevalence of diabetes in these risk factors. Furthermore, it is recommended in the future to conduct multilevel analysis to explain more about the risk factors in individual and district level.

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CONFLICT OF INTEREST DISCLOSURE

The authors hereby declare that there is no conflict of interest.

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