

The prevalence of diabetes mellitus and relationship with socioeconomic status in the Indonesian population

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ABSTRACT

Background: The prevalence of diabetes mellitus is increasing globally and remains debated. **Objective:** This study examines the association of socioeconomic status with the prevalence of diabetes mellitus in Indonesia. **Methods:** This study used a cross-sectional design. Data obtained from the 2014 Indonesia Family Life Survey (IFLS), a nationally representative population survey data, which polled 30,497 individuals age 16 years and over in 13 provinces in Indonesia. Logistic regression models were used to estimate odds ratios (OR) and 95% confidence intervals (CI) for the prevalence of diabetes mellitus with socioeconomic status. **Results:** Education level, employment status, age, and hypertension are related to the prevalence of diabetes mellitus. According to educational level, individuals with lower education level were more likely to have diabetes mellitus than those who had a higher level of education (OR=1.42; 95% CI: 1.21-1.67), higher risk was also found in those who were unemployed (OR=1.55; 95% CI: 1.33-1.82). Besides, age and hypertension were independent factors for a higher prevalence of diabetes mellitus, age >55 (OR=4.71; 95% CI: 4.06-5.46), hypertension (OR=5.86; 95% CI: 5.00-6.87). Diabetes mellitus also show significantly higher among individuals living in urban areas compared to individuals living in rural areas (OR=2.13; 95% CI: 1.78-2.55). **Conclusions:** Socioeconomic status has a significant association with the prevalence of diabetes mellitus among people above 15 years old in Indonesia. The government needs to design a preventive program to control this disease by considering the risk factors that may lead to the development of diabetes mellitus in Indonesia.

KEYWORDS: diabetes mellitus; Indonesia; prevalence; socioeconomic

INTRODUCTION

Diabetes is a metabolic disease characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both. Chronic hyperglycemia due to diabetes is associated with long-term damage, dysfunction, and organ failure, especially the eyes, kidneys, nerves, heart, and blood vessels (1). Diabetes mellitus is not a single disorder and its definition depends on one's perspective. The definition of diabetes from a social point of view includes the burden that this disease poses on the economy, both in terms of expensive treatment and associated premature morbidity and mortality (2).

Diabetes mellitus is a chronic disease that occurs in developed and developing countries (3). According to Global Report on Diabetes from World Health Organization records in 2014 were 422 million people in the world suffer from diabetes, and caused 1.5 million deaths in 2012 (4). A study estimates that more than 500 million people worldwide will suffer from diabetes by 2030 (5). Over the past three decades, the prevalence of diabetes in Indonesia has increased substantially. With a population of more than 200 million, Indonesia ranks among the top seventh countries in the world for the incidence and prevalence of diabetes mellitus (4). The incidence of diabetes reported by the Ministry of

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Health Data and Information Center from the results of the Basic Health Research (Riskesdas) in 2013 stated that the proportion of diabetes mellitus in the population aged over 15 years was recorded at 6.9% and an increase of 2% in 2018 (6,7).

In the past two decades, researchers have examined various factors that cause diabetes mellitus. Health researchers reveal that in general the factors that cause diabetes mellitus include being overweight, obesity, and a high calorie diet (2). In recent studies, researchers have revealed the relationship between socioeconomic status that can play a role in the prevalence of diabetes mellitus (8). Socioeconomic status is a total measure of an individual's or families economic and social position (5). Some socioeconomic status factors are identified as risk factors having an association with diabetes mellitus. Previous studies used education, income, and employment as a primary measure of socioeconomic status (9-12). Previous studies examined various socio-demographic variables for diabetes mellitus. Age, gender, marital status, and living area were used to measure the socio-demographics of individual (13). Some recent studies, lifestyle has been widely studied against the prevalence of diabetes mellitus (14,15).

Over the past two decades, the influence of socioeconomic status on the prevalence of diabetes mellitus have been increasing attention in health and social researcher. The researchers argue that there are socioeconomic inequalities in the prevalence of diabetes mellitus (16). Most studies show that socioeconomic status is related to the prevalence of diabetes mellitus (12, 17-19). Individuals with low socioeconomic status have a high risk of diabetes. Prior studies have reported both low income and low educational attainment are significantly associated with increased prevalence of diabetes mellitus (20).

Previous studies provide knowledge to understand the effect of socioeconomic status on prevalence of diabetes mellitus. Most of the previous studies focused on the effect of socioeconomic status on the prevalence of diabetes mellitus in developed country, particularly in America and Europe and some countries in Asia. In developed countries, socioeconomic status is continuous and significantly predict the risk of developing diabetes.

Although studies in developing countries are not widely conducted and the relationship is still in doubt, so far there has been no studies that indicate high socioeconomic status related to diabetes mellitus risk.

The purpose of this study is to investigate the impact of socioeconomic status on diabetes mellitus in Indonesia. We use Indonesia, a developing country which estimated in 2020 was 8.4 million people, and became the 4th largest country with most diabetic patients (7). Second, we uses a national representative survey, the *Indonesian Family Life Survey* was used for this study. IFLS is a unique household survey in Indonesia. The IFLS provides longitudinal data representing 80% nationally of the entire Indonesian population living in 13 of the 26 provinces. This survey collects respondents' data on various socioeconomic and sociodemographic variables at the level of individuals, families, households and communities, and includes education and employment. The first wave of IFLS was carried out in 1993 for individuals living in 7,224 households. IFLS 3 and 4 re-interviewed the same respondents in 1997 and 2007. IFLS 5 was reported in 2014 in the same IFLS household group with a participation rate of 92% with 16,204 households and 50,148 individuals (21). For this study, we selected individuals who completed questionnaires in chronic diseases and several questionnaires relating to social, economic, and demografis information. The subjects included in this study were aged 15 and over who were Indonesian citizens based on the IFLS 4 study. This resulted in as a sample of 30,497 individuals.

METHODS

Study design and participants

This cross-sectional study was used from the Indonesian Family Life Survey (IFLS). The IFLS is an ongoing social, economic, and longitudinal health survey in Indonesia. IFLS data represent 80% of the population in Indonesia, IFLS survey were conducted in 13 provinces in Indonesia. This study uses the latest data, IFLS 5, launched in late 2014 and early 2015. IFLS 5 data consists of 16,204 households and 50,148 individuals. In this study, the sample was limited to respondents with a minimum age of 15 years who answered a complete

survey about chronic diabetes mellitus. This resulted in a sample of 30,497 individuals.

Measures

Diabetes mellitus. Diabetes mellitus has been measured by two categories of items based on the classification of the International Classification of Disease and Related Health Problems 10th revision (1). In the IFLS survey, individuals were asked a questionnaire about “Has the doctor / nurse / midwife ever said that you have a condition / disease of diabetes mellitus?”. Responses were recorded in two categories (1 = suffering from diabetes mellitus, 0 = not suffering from diabetes mellitus).

Over the past two decades, previous studies have documented levels of education, employment status, home ownership, age, gender, marital status, living room, smoking, sleep quality, physical activity, hypertension, and dietary fat intakes as determining factors for the prevalence of diabetes mellitus. Thus, this study examines the prevalence of diabetes mellitus by controlling for these variables.

Socioeconomic status. Socioeconomic status refers to the social and economic factors that reflect what positions and prestige individuals or groups hold within the structure of a society, such as educational level, employment status and income (18,22). The main indicators socioeconomic status in this study were include education, employment status, and housing ownership. In this study, education is categorized based on education standards in Indonesia, from the lowest level of elementary school to the highest level of university. In this study we added responses to unshool level education based on data available at IFLS. Most respondents have completed senior high school in the education system in Indonesia. In this study we used dummy variables to distinguish individual employment status, 1) indicating unemployed and 0) indicating being employed. We use questions in the IFLS survey that asks respondents, “What is the status of your home?” The dummy variable is used to indicate the status of home ownership, with 1) indicating own / owner and 0) leased / contracted.

Sociodemographic. In this study, we also used sociodemographic variables to examine its relationship with diabetes mellitus risk. Age, gender, marital status

and area of residence have documented in relation to the risk of diabetes mellitus (17). Age is reclassified into five categories as follows: 1) 15 - 24 years; 2) 25 - 34 years; 3) 35 - 44 years; 4) 45 - 54 years; 5) 55 years and above, twenty-seven percent of respondents were 25-24 years old. Gender was measured using a dummy variable, 1) for female and 0) for male. Marital status is also measured using a dummy variable with 1) married and 0) un-married, the category of un-married included single / divorced / widowed, seventy-four percent of respondents are married. A dummy variable indicating place of residence with 1) urban and 0) rural. Most respondents live in an urban areas.

Livestyle. Researchers have documented that lifestyle is associated with diabetes mellitus (14). The main indicators of lifestyle in this study were included smoking, sleep quality, physical activity, hypertension, and dietary fat intake.

Smoking. We use questions in the IFLS survey that asks “Have you ever chewed tobacco, smoked, smoked alone or smoked cigar /cigars?” the dummy variable is used by 1) indicating smoking before and currently and 0) indicating never-smoking.

Sleep quality. The IFLS survey asks about sleep with question “My sleep quality is very bad, fair, good, very good?” The first three categories are combined into 1) indicating good quality and 0) indicating poor quality.

Physical activities. We use questions that ask “Heavy activities that require hard physical effort that you have undertaken in the last 7 days. Heavy activities make you breathe much harder than usual and may include lifting, digging, plowing, aerobics, fast cycling, cycling with a load of”, dummy variables used to indicated individuals’ who engage in active activities less than 10 minutes per day in a week 1) and more than 10 minutes per day a week 0).

Hypertension. Hypertension also has a determining effect on diabetes mellitus in developed and developing country. We measure hypertension by asking “Did your doctor / nurse / midwife ever say that you have hypertension?”. Responses are recorded in two categories 1) suffering from hypertension, 0) not suffering from hypertension. The percentage of respondents who suffer from hypertension is 12 %.

Dietary fat intake. A dummy variable indicating above-median dietary fat intake 1) and below-median dietary fat intake 0). The median dietary fat intake is a three-time a week.

Data analysis

Statistical analyses were conducted using Rstudio Version 1.1.463. Our statistical analysis in this study were: 1) Descriptive analysis, including frequencies and percentages for categorical and dummy variable; 2) Bivariate analysis to show the relationship between diabetes mellitus and related variables; 3) Multiple logistic linear regression was then performed to assess the association between diabetes and three factors of SES (education, employment, and home ownership). The model was fitted after adjusting for study covariates including age, gender, marital status, place of residence, smoking, sleep quality, physical activity, hypertension, and dietary fat intake. The results are presented as Odds Ratios (ORs) with 95% confidence intervals (95% CI).

RESULTS

We first review the characteristics of study sample with diabetes mellitus and a bivariate correlation analysis is shown in **Table 1**. Among 30,497 respondents aged >15 years, 684 (2.24%) were identified as having diabetes mellitus. The higher prevalence of diabetes mellitus was in respondents who have hypertension, approximately 7.98% and 7.01% of respondents aged (>55 years). Correlation between socioeconomic status and other related factors were tested. Bivariate analysis shows the correlation between diabetes mellitus and independent variables in **Table 2**. Most of the independent variables show a significant relationship. Socioeconomic status as measured by education level, employment status, and home ownership shows a significant relationship with the prevalence of diabetes mellitus. Education, negatively related to diabetes mellitus. Age also shows significantly associated with diabetes mellitus, with older individuals (45 years and above) at greater prevalence of diabetes mellitus. Married people and female individuals are more likely to deal with diabetes mellitus compared to un-married and male.

Gender has not significantly related to diabetes mellitus. People who live in rural areas are less likely to face diabetes mellitus compared to people who live in urban areas. According to bivariate analysis, there is no significant relationship between smoking behaviour with diabetes mellitus. Thus, sleep quality, physical activity, hypertension, and dietary intake all showed significant association with diabetes mellitus.

DISCUSSION

Using nationally representative data, we assessed the socioeconomic determinant and other related factors on prevalence of diabetes mellitus in the Indonesian population. According to previous studies, there has been an increasing trend in the prevalence of diabetes mellitus in Indonesia. Diabetes mellitus had become a global health problem. The highest prevalence of diabetes mellitus is found in developing countries. The main findings show that socioeconomic status according to education level, employment status, and home ownership was related to prevalence of diabetes mellitus among individuals aged 16 years and over. Our findings support previous studies (23,24). However, the findings of this study do not support the previous studies (25).

There are several possible explanations of how socioeconomic status affects the prevalence of diabetes mellitus. First, improving education tends to reduce the risk of diabetes mellitus. This finding has been explained in several previous studies (8,9). Level of education is one of the factors determining a person's behavior. Our analysis showed that diabetes mellitus mostly affected those with low level of education compared to people with moderate and high levels of education. Conversely, individuals with low levels of education are more likely to get diabetes mellitus than individuals with high levels of education (26). Higher educational level provides individuals with more knowledge for understanding health risk factor, improving individuals' health choices, and earning power, which give better access and quality of health care, and may reduce the risks of diabetes mellitus (27,28). In addition, low educational level may simply reflect unhealthy behaviours, such as smoking, poor sleep quality, physical inactivity, which in turn lead to

Table 1. Characteristic of the study sample: Indonesia Family Live Survey 2014

Characteristics	IFLS samples		Diabetes mellitus		Bivariate correlation
	n	%	n	%	
	30,497	100	684	2.24	
Education					-0.01*
Elementary school and unschool	10,434	34.21	291	42.54	
Junior high school	5,696	18.68	96	14.03	
Senior high school	10,032	32.90	173	25.29	
Graduate and upper	4,335	14.21	124	18.12	
Employment					0.03*
Unemployed	9,616	31.53	284	41.52	
Employed	20,881	68.47	400	58.48	
Home ownership					0.03*
Owner	22,835	74.88	572	83.62	
Leased / contracted	7,662	25.12	112	16.37	
Age (years)					0.15*
15 – 24	6,771	22.20	12	1.75	
25 – 34	8,502	27.88	62	9.06	
35 – 44	6,592	21.62	106	15.40	
45 – 44	4,472	14.66	212	30.99	
> 55	4,160	13.64	292	42.69	
Gender					0.00
Female	16,267	53.34	369	53.94	
Male	14,230	46.66	315	46.06	
Martital status					0.03*
Married	22,739	74.56	571	83.47	
Un-married	7,758	25.44	113	16.53	
Place of residence					0.04*
Urban	17,981	58.96	514	75.14	
Rural	12,516	41.04	170	24.86	
Smoking					-0.00
Before and current	11,134	36.51	246	35.96	
Never smoking	19,363	63.49	438	64.04	
Sleep quality					0.01*
Poor	3,619	11.87	101	14.77	
Good	26,878	88.13	583	85.23	
Physical activity					0.03*
Heavy activity <10 minutes/days a week	23,741	77.85	592	86.55	
Heavy activity >10 minutes/days a week	6,756	22.15	92	13.45	
Hypertension					0.14*
Yes	3,671	12.04	293	42.84	
No	26,826	87.96	391	57.16	
Dietary fat intake					0.01*
Above median fat intake	14,339	47.02	325	47.51	
Below median fat intake	16,158	52.98	359	52.49	

*p < 0.05

the occurrence of diabetes mellitus. Employment status is related to the development of diabetes mellitus (17). Our analysis show the higher risk of diabetes mellitus among the unemployed respondent than among the employed

ones. Individuals who do not work have a higher risk of diabetes than individuals who do work. Previous studies noted that males and females who do not work have a risk of diabetes mellitus (17,29).

Table 2. Odds Ratios (95% confidence intervals) for prevalence of diabetes mellitus: Indonesia Family Life Survey 2014

Characteristics	Odds Ratio	Confidence Interval	p
Education			
Junior high school and upper	Ref		
Elementary school and unschool	1.42	1.21 – 1.67	0.000
Employment			
Employed	Ref		
Unemployed	1.55	1.33 – 1.82	0.000
Housing ownership			
Leased / contracted	Ref		
Owner	1.73	1.40 – 2.14	0.000
Age			
≤ 45	Ref		
≥ 45	2.61	2.22 – 3.06	0.000
Sex			
Male	Ref		
Female	1.02	0.87 – 1.20	0.747
Marital status			
Un-married	Ref		
Married	1.74	1.41 – 2.15	0.000
Place of residence			
Rural	Ref		
Urban	2.13	1.78 – 2.55	0.000
Smoking			
Never	Ref		
Before and currently	1.02	0.87 – 1.82	0.765
Quality of sleep			
Good	Ref		
Poor	1.29	1.02 – 1.60	0.017
Physical activity			
Heavy activity >10 minutes/days a week	Ref		
Heavy activity <10 minutes/days a week	1.85	1.48 – 2.33	0.000
Hypertension			
Not suffering	Ref		
Suffering	5.86	5.00 – 6.87	0.000
Dietary fat intake			
Below median fat intake	Ref		
Above median fat intake	1.29	1.06 – 1.57	0.007

*p < 0.05

Other main finding shows that the results are not a significant prevalence of diabetes mellitus in females. Both males and females have same level of risk of developing diabetes mellitus. These findings indicate there is no difference in the prevalence of diabetes mellitus between males and females. Confirming previous studies, males and females have a similar risk of diabetes mellitus (30,31). Marital status is related to diabetes mellitus. Result from our bivariate analysis show that

the highest proportion of diabetes mellitus was found among married respondents, compared to those who were un-married. Our finding show that an association between marital status and development of diabetes mellitus. Married individuals were more likely to develop the diabetes mellitus than those who had never married. This support previous studies that found greater number of diabetes mellitus case on who had never married (17). Another important finding was that the prevalence

of diabetes mellitus is higher in individuals living in rural areas. Our statistical analysis found a significant association between living area and the development of diabetes mellitus. This finding suggests that environmental factors play a role in the development of diabetes mellitus. This finding confirms previous findings which noted that there is a high risk of diabetes mellitus in urban areas compared to rural areas (32,33), this finding contradicts previous studies that have found that the risk of diabetes mellitus is higher in rural areas (33).

The most interesting finding was that age and incidence of hypertension can be an important factor in the prevalence of diabetes mellitus in Indonesia. The effect of age has been widely documented in previous studies (17,34). Diabetes risk shows a trend that increases significantly with age. Individuals aged 35-44 have a higher risk of diabetes mellitus, and this association increases with age. Individuals over the age of 55 are five times more at risk of developing diabetes mellitus. The older the age, the higher the risk to develop diabetes mellitus. Hypertension is the strongest factor of diabetes mellitus, our finding shows a higher risk of diabetes mellitus in individuals with symptoms of hypertension. Hypertension was also associated significantly with the development of diabetes mellitus. Previous studies have reported that diabetes and hypertension can develop one after another in the same individual (35,36). Our finding also indicates a negative effect of sleep quality on diabetes mellitus. Confirming previous studies, our finding demonstrates that a decrease in sleep quality can increase the risk of diabetes, this finding of sleep quality consistently and significantly predicts the risk of developing diabetes (37-40).

Another explanation that might underlie the relationship between SES and gestational diabetes is dietary fat intake. Excessive dietary fat intake has the potential to increase diabetes mellitus. The average dietary fat intake of each individual is three to four times a week. Previous studies have reported a high prevalence of diabetes mellitus in people who consume excess fat (41,42). In contrast, previous studies have shown that controlling the consumption of fatty foods tends to reduce the risk of diabetes mellitus (42,43). The benefits of physical activity for diabetes mellitus have been reported in previous studies in both developed and

developing countries (44-46). Physical activity can help reduce blood sugar levels in diabetics. Physical activity, especially in high and moderate intensity, can help reduce body fat level and the risk of diabetes mellitus (47). This finding supports previous study (48,49). Our finding also indicates the harmful effects of smoking on prevalence of diabetes mellitus but not significantly. These findings reveal that there is no difference in the prevalence of diabetes mellitus in individuals who smoke and do not smoke. This finding contradicts previous studies (50). Therefore, in order to reduce the risk of diabetes mellitus, strong determination is needed to change one's lifestyle to become more healthy and active.

This study has a number of limitations. This study uses a cross-sectional data design. Thus, the long-term prevalence of diabetes mellitus in individuals is not observed. The next weakness is that it does not include income indicators in socioeconomic status measures. Income is an important indicator of socioeconomic status that is not examined. Previous studies included the level of education and income of individuals as the main key indicators of measurement of socioeconomic status.

CONCLUSIONS

This study indicated that socioeconomic status has been associated with diabetes mellitus. The prevalence of diabetes mellitus tends to increase every year in Indonesia. Those with low educational level, unemployed, house owner, old age, female, married, living in urban areas, smoking, poor sleep quality, light physical activity, hypertension, and excessive dietary fat intake were vulnerable to diabetes mellitus. The government needs to design a preventive program to control this disease by considering the risk factors that may lead to the development of diabetes mellitus in Indonesia. Future studies are expected to examine the effect of socioeconomic status on the risk of diabetes mellitus with long-term study and measure socioeconomic status with more complete indicators including individual income.

Declaration of conflicting interests

The authors declare that they have no conflict of interest in this study.

REFERENCES

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2014;37(Supp 1):S81-90. doi: 10.2337/dc14-S081
2. Egan AM, Dinneen SF. What is diabetes?. *Medicine*. 2014;42(12):678-81. doi: 10.1016/j.mpmed.2014.09.005
3. Xu Z, Yu D, Yin X, Zheng F, Li H. Socioeconomic status is associated with global diabetes prevalence. *Oncotarget*. 2017;8(27):44434-9. doi: 10.18632/oncotarget.17902
4. WHO. Global report on diabetes. [series online] 2016 [cited 2019 Oct 18]. Available from: URL: <https://www.who.int/publications/i/item/9789241565257>
5. Hu FB. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes Care*. 2011;34(6):1249-57. doi: 10.2337/dc11-0442
6. Pusat Data dan Informasi, Kementerian Kesehatan RI. Situasi dan analisis diabetes. [series online] 2014 [cited 2019 Oct 18]. Available from: URL: <https://www.kemkes.go.id/download.php?file=download/pusdatin/infodatin/infodatin-diabetes.pdf>
7. Pusat Data dan Informasi, Kementerian Kesehatan RI. Hari diabetes sedunia tahun 2018. [series online] 2019 [cited 2019 Oct 18]. Available from: URL: <https://pusdatin.kemkes.go.id/download.php?file=download/pusdatin/infodatin/infodatin-Diabetes-2018.pdf>
8. Hwang J, Shon C. Relationship between socioeconomic status and type 2 diabetes : results from Korea National Health and Nutrition Examination Survey (KNHANES) 2010 – 2012. *BMJ Open*. 2014;4(8):e005710. doi: <https://doi.org/10.1136/bmjopen-2014-005710>
9. Kim YJ, Jeon JY, Han SJ, Kim HJ, Lee KW, Kim DJ. Effect of socio-economic status on the prevalence of diabetes. *Yonsei Med J*. 2015;56(3):641-7. doi: 10.3349/ymj.2015.56.3.641
10. Koo BK, Kim SW, Yi KH, Moon MK. Low economic status is identified as an emerging risk factor for diabetes mellitus in Korean men aged 30 to 59 years in Korean National Health and Nutrition Examination Survey 2008 to 2010. *Diabetes Metab J*. 2015;39(2):137-46. doi: 10.4093/dmj.2015.39.2.137
11. J. F. Elgart, J. L. De La, C. Camilluci, J. B. Brown, C. D. Gonza. Association between socioeconomic status, type 2 diabetes and its chronic complications in Argentina. *Diabetes Res Clin Pract*. 2014;104(2):241-7. doi: 10.1016/j.diabres.2014.02.010
12. Kowall, Rathmann W, Strassburger K, Meisinger C, Holle R, Mielck A. Socioeconomic status is not associated with type 2 diabetes incidence in an elderly population in Germany : KORA S4 / F4 Cohort Study. *J Epidemiol Community Health*. 2011;65:606-12. doi: 10.1136/jech.2009.094086
13. Funakoshi M, Azami Y, Matsumoto H, Ikota A, Ito K, Miura J, et al. Socioeconomic status and type 2 diabetes complications among young adult patients in Japan. *PLoS One*. 2017;12(4):e0176087. doi: 10.1371/journal.pone.0176087
14. Rahati S, Shahraki M, Arjomand G, Shahraki T. Food pattern, lifestyle and diabetes mellitus. *Int J High Risk Behav Addict*. 2014;3(1):e8725. doi: 10.5812/ijhrba.8725
15. Lindstrom J, Uusitupa M. Lifestyle intervention, diabetes, and cardiovascular disease. *Lancet*. 2008;371(9626):1731-3. doi: 10.1016/S0140-6736(08)60740-0
16. Gnani R, Karaghiosoff L, Costa G, Merletti F, Bruno G. Socio-economic differences in the prevalence of diabetes in Italy: the population-based Turin study. *Nutr Metab Cardiovasc Dis*. 2008;18(10):678-82. doi: 10.1016/j.numecd.2007.11.004
17. Idris H, Hasyim H, Utama F. Analysis of diabetes mellitus determinants in indonesia : a study from the Indonesian Basic Health Research 2013. *Acta Med Indones*. 2017;49(4):291-8.
18. Song L, Shen L, Li H, Liu B, Zheng X, Wang Y, et al. Socio-economic status and risk of gestational diabetes mellitus among Chinese women. *Diabet Med*. 2017;34(10):1421-7. doi: 10.1111/dme.13415
19. Liu J, Liu E, Leng J, Pan L, Zhang C, Yang X, et al. Indicators of socio-economic status and risk of gestational diabetes mellitus in pregnant women in urban Tianjin, China. *Diabetes Res Clin Pract*. 2018;144:192-9. doi: 10.1016/j.diabres.2018.08.023
20. Berkowitz SA, Karter AJ, Lyles CR, Liu JY, Schillinger D, Sarkar U, et al. Low socioeconomic status is associated with increased risk for hypoglycemia in diabetes patients: the Diabetes Study of Northern California (DISTANCE). *J Health Care Poor Underserved*. 2014;25(2):478-90. doi: 10.1353/hpu.2014.0106
21. Strauss J, Witoelar F, Sikoki B. User's guide for the Indonesia Family Life Survey, wave 5. [series online] 2016 [cited 2019 Oct 18]. Available from: URL: https://www.rand.org/content/dam/rand/pubs/working_papers/WR1100/WR1143z2/RAND_WR1143z2.pdf
22. Conger RD, Donnellan MB. An interactionist perspective on the socioeconomic context of human development. *Annu Rev Psychol*. 2007;58:175-99. doi: 10.1146/annurev.psych.58.110405.085551
23. Rabi DM, Edwards AL, Southern DA, Svenson LW, Sargious PM, Ghali WA, et al. Association of socioeconomic status with diabetes prevalence and utilization of diabetes care services. *BMC Health Serv Res*. 2006;6:124. doi: 10.1186/1472-6963-6-124
24. Aekplakorn W, Chariyalertsak S, Kessomboon P, Assanangkornchai S, Taneepanichskul S, Putwatana

- P. Prevalence of diabetes and relationship with socioeconomic status in the Thai population: National Health Examination Survey, 2004-2014. *J Diabetes Res.* 2018;2018:1654530. doi: 10.1155/2018/1654530
25. Zhu S, Hu J, McCoy TP, Li G, Zhu J, Kong L, et al. Socioeconomic status and the prevalence of type 2 diabetes among adults in Northwest China. *Diabetes Educ.* 2015;41(5):599-608. doi: 10.1177/0145721715598382
 26. Espelt A, Borrell C, Roskam AJ, Rodríguez-Sanz M, Stirbu I, Kunst AE, et al. Socioeconomic inequalities in diabetes mellitus across Europe at the beginning of the 21st century. *Diabetologia.* 2008;51(11):1971-9. doi: 10.1007/s00125-008-1146-1
 27. Lee TC, Glynn RJ, Pena JM, Paynter NP, Albert MA, et al. Socioeconomic status and incident type 2 diabetes mellitus : data from the Women's Health Study. *PLoS One.* 2011;6(12):e27670. doi: 10.1371/journal.pone.0027670
 28. Braveman PA, Cubbin C, Egerter S, Williams DR, Pamuk E. Socioeconomic disparities in health in the United States: what the patterns tell us. *Am J Public Health.* 2010;100 Suppl 1(Suppl 1):S186-96. doi: 10.2105/AJPH.2009.166082
 29. Agardh E, Allebeck P, Hallqvist J, Moradi T, Sidorchuk A. *Int J Epidemiol.* 2011;40(3):804-18. doi: 10.1093/ije/dyr029
 30. Steck AK, Rewers MJ. Epidemiology and risk factors for type 1 diabetes mellitus. In: *International textbook of diabetes mellitus.* [series online] 2015 [cited 2019 Oct 18]. Available from: URL: doi: 10.1002/9781118387658.ch2
 31. Gale EA, Gillespie KM. Diabetes and gender. *Diabetologia.* 2001;44(1):3-15. doi: 10.1007/s001250051573
 32. Suwannaphant K, Laohasiriwong W, Puttanapong N, Saengsuwan J, Phajan T. Association between socioeconomic status and diabetes mellitus: the National Socioeconomics Survey, 2010 and 2012. *J Clin Diagn Res.* 2017;11(7):LC18-22. doi: 10.7860/JCDR/2017/28221.10286
 33. Fano V, Pezzotti P, Gnani R, Bontempi K, Miceli M, Fortino A, et al. The role of socio-economic factors on prevalence and health outcomes of persons with diabetes in Rome, Italy. *Eur J Public Health.* 2013;23(6):991-7. doi: 10.1093/eurpub/cks168
 34. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, et al. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. *Diabetologia.* 2001;44(9):1094-101. doi: 10.1007/s001250100627
 35. Cheung BMY, Li C. Diabetes and hypertension: is there a common metabolic pathway?. *Curr Atheroscler Rep.* 2012 Apr;14(2):160-6. doi: 10.1007/s11883-012-0227-2
 36. Lago RM, Singh PP, Nesto RW. Diabetes and hypertension. *Nat Clin Pract Endocrinol Metab.* 2007;3(10):667. doi: 10.1038/ncpendmet0638
 37. Knutson KL, Ryden AM, Mander BA, Cauter EV. Role of sleep duration and quality in the risk and severity of type 2 diabetes mellitus. *Arch Intern Med.* 2006;166(16):1768-74. doi: 10.1001/archinte.166.16.1768
 38. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes. *Diabetes Care.* 2010;33(2):414-20. doi: 10.2337/dc09-1124
 39. Luyster FS, Dunbar-Jacob J. Sleep quality and quality of life in adults with type 2 diabetes. *Diabetes Educ.* 2011;37(3):347-55. doi: 10.1177/0145721711400663
 40. Chasens ER, Korytkowski M, Sereika SM, Burke LE. Effect of poor sleep quality and excessive daytime sleepiness on factors associated with diabetes self-management. *Diabetes Educ.* 2013;39(1):74-82. doi: 10.1177/0145721712467683
 41. Buijsse B, Boeing H, Drogan D, Schulze, Feskens EJ, Wareham NJ, et al. Consumption of fatty foods and incident type 2 diabetes in populations from eight European countries. *Eur J Clin Nutr.* 2015;69(4):455-61. doi: 10.1038/ejcn.2014.249
 42. Riséus U, Willett WC, Hu FB. Dietary fats and prevention of type 2 diabetes. *Prog Lipid Res.* 2009;48(1):44-51. doi: 10.1016/j.plipres.2008.10.002
 43. Venn BJ, Mann JI. Cereal grains, legumes and diabetes. *Eur J Clin Nutr.* 2004;58(11):1443-61. doi: 10.1038/sj.ejcn.1601995
 44. Hemmingsen B, Gimenez-Perez G, Mauricio D, Figuls MRI, Metzendorf M, Richter B. Diet, physical activity or both for prevention or delay of type 2 diabetes mellitus and its associated complications in people at increased risk of developing type 2 diabetes mellitus. *Cochrane Database Syst Rev.* 2017;12(12):CD003054. doi: 10.1002/14651858.CD003054.pub4
 45. Malkawi AM. The effectiveness of physical activity in preventing type 2 diabetes in high risk individuals using well-structured interventions : a systematic review. *J Diabetol.* 2012;3(2):5.
 46. Ughreja RA, Ughreja RA. Type 2 diabetes mellitus, physical activity, yoga and telomere length: a literature review. *Journal of Insulin Resistance.* 2019;4(1):1-9. doi: 10.4102/jir.v4i1.52
 47. Simbolon D, Siregar A, Talib RA. Physiological factors and physical activity contribute to the incidence of type 2 diabetes mellitus in Indonesia. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal).* 2020;15(3):120-7. doi: 10.21109/kesmas.v15i3.3354

48. Hamasaki H. Daily physical activity and type 2 diabetes: a review. *World J Diabetes*. 2016;7(12):243-51. doi: 10.4239/wjd.v7.i12.243
49. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. Physical activity/exercise and type 2 diabetes. *Diabetes Care*. 2006;29(6):1433-8. doi: 10.2337/dc06-9910
50. Padmawati RS, Ng N, Prabandari YS, Nichter M. Smoking among diabetes patients in Yogyakarta, Indonesia: cessation efforts are urgently needed. *Trop Med Int Health*. 2009;14(4):412-9. doi: 10.1111/j.1365-3156.2009.02241.x