Vol. 8, No. 1, April 2026, pp 1-13
https://doi.org/10.36590/jika.v7i2.853
http://salnesia.id/index.php/jika
jika@salnesia.id, p-ISSN: 2337-9847, e-ISSN: 2686-2883
Penerbit: Sarana Ilmu Indonesia (salnesia)

RESEARCH ARTICLES

Aktivitas Fisik yang Berhubungan dengan Kadar Glukosa Sewaktu pada Pasien Dewasa di Yogyakarta: Studi Kasus-Kontrol

Physical Activity Related to Random Glucose Levels in Adult Patients in Yogyakarta: A Case-Control Study

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Abstract

High blood sugar levels are a sign of impaired metabolism in the body. High blood sugar levels with clinical symptoms are the cause of type 2 diabetes mellitus. The aim of the study was to determine the risk factors for blood sugar levels based on community participation through early detection and monitoring of the main risk factors for non-communicable diseases at POSBINDU in the city of Yogyakarta. Data were obtained from the Non-Communicable Disease Information System (NCD-IS) of the Yogyakarta City Health Office in January - June 2022. The study was conducted with a case-control study (cases to controls ratio 1:2) with matched by sex and age group. Cases are people who have blood sugar levels ≥200 mg/dL as many as 169 people. Controls were people with blood sugar levels <200 mg/dL, with a total of 338 people. The analytical test used was the Chi-square test. Physical activity was significantly associated (p-value 0.009; 95% CI 0.55 – 0.91). There is a relationship between lack of physical activity and with the incidence of abnormal blood sugar levels. Lack of physical activity affects blood sugar levels to be abnormal.

Keywords: physical activity, random glucose level, risk factors

Article history :

Submitted 28 November 2023
Accepted 10 February 2026
Published 30 April 2026

PUBLISHED BY:
Sarana Ilmu Indonesia (salnesia)
Address:
Jl. Dr. Ratulangi No. 75A, Baju Bodoa, Maros Baru, Kab. Maros, Provinsi Sulawesi Selatan, Indonesia

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Abstrak

Kadar gula darah yang tinggi merupakan tanda adanya gangguan metabolisme dalam tubuh. Kadar gula darah yang tinggi disertai gejala klinis dapat menjadi penyebab terjadinya Diabetes Melitus (DM) tipe II. Penelitian ini bertujuan untuk mengetahui faktor risiko kadar gula darah berdasarkan partisipasi masyarakat melalui deteksi dini dan pemantauan faktor risiko utama penyakit tidak menular di POSBINDU Kota Yogyakarta. Data diperoleh dari Sistem Informasi Penyakit Tidak Menular (PTM) Dinas Kesehatan Kota Yogyakarta pada periode Januari–Juni 2022. Penelitian ini menggunakan desain studi kasus-kontrol (perbandingan kasus dan kontrol 1:2) dengan pencocokan berdasarkan jenis kelamin dan kelompok umur. Kelompok kasus adalah individu dengan kadar gula darah ≥200 mg/dL sebanyak 169 orang, sedangkan kelompok kontrol adalah individu dengan kadar gula darah <200 mg/dL sebanyak 338 orang. Uji analisis yang digunakan adalah Chi-square. Hasil penelitian menunjukkan bahwa aktivitas fisik memiliki hubungan yang signifikan dengan kadar gula darah (p-value 0,009; 95% CI 0,55–0,91). Terdapat hubungan antara tidak melakukan aktivitas fisik dengan kejadian kadar gula darah yang tidak normal. Kurangnya aktivitas fisik dapat meningkatkan kadar gula darah menjadi tidak normal.

Kata Kunci: *aktivitas fisik, kadar glukosa sewaktu, faktor risiko*

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Highlight:

- Physical activity is significantly associated with random blood glucose levels among adult patients (*p-value* = 0.009).
- A lack of physical activity serves as a prominent risk factor that leads to abnormal blood sugar levels (≥200 mg/dL).
- Statistical analysis shows an Odds Ratio (OR) of 0.71 with a 95% Confidence Interval (CI) between 0.55 and 0.91, reinforcing the notable link between physical activity and glucose regulation.

INTRODUCTION

Diabetes is a disease in the form of a metabolic disorder characterized by blood sugar levels that exceed normal limits. The normal value of Random Blood Glucose (RGB) or without fasting is 200 mg/dL, while the normal level of fasting blood sugar (GDP) is <126 mg/dl (Rodgers, 2020).

The global prevalence of diabetes in adults has increased over the last few decades to reach (8,3%) in 2019, is expected to increase (9,2%) in 2030, and (9,6%) in 2045 (Cho et al., 2018; WHO, 2016). Furthermore, the development of diabetes prevalence cases has increased by 11,3% in 2019, is expected to increase to 12,2% in 2030, and 12,6% in 2045 in South Asia. It is known that Indonesia is ranked seventh (10,7%) prevalence of diabetes in the world in 2019 after Mexico. The development of the prevalence of Type 2 DM has increased from (1,1%) in 2007, (6,9%) in 2013, (7,0%) in 2016, (8,5%) in 2018, and (10,7%) in 2019 in Indonesia (IDF, 2017; Kemenkes, 2020).

The prevalence of diabetes mellitus in the Special Region of Yogyakarta is still

well above the national average, which is 4,5% of the national figure which is only 2,4%. The prevalence of diabetes mellitus in women is higher than in men with a ratio of 1,7% and 1,4% in 2013, in 2018 1,78% and 1,21% (Kemenkes, 2020). Women are more likely to experience higher blood sugar levels than men because they have the hormone estrogen as a trigger (ADA, 2018).

Diabetes mellitus incidence rate is influenced by several risk factors or precipitating factors. Diabetes risk factors consist of factors that can be modified or changed and factors that cannot be changed. Risk factors that cannot be changed are ethnicity, race, gender, age, family history of diabetes mellitus, history of giving birth to babies >4,000 grams, and history of low birth weight (LBW) or <2,500 grams (Hjort et al., 2017; Nuraisyah et al., 2020; Zhao et al., 2017). Meanwhile, modifiable risk factors include smoking behavior, lack of physical activity, excess body weight, abnormal abdominal circumference, hypertension, blood sugar levels, unbalanced diet (high in calories), dyslipidemia, and prediabetes with marked glucose tolerance. impaired (BPG 140-199 mg/dl) or impaired fasting blood glucose (GDPT <140 mg/dl) (Katulanda et al., 2016).

The community plays an important role in controlling diabetes through Community-Based Health Efforts (UKBM) implemented at the Integrated Development Post for Non-Communicable Diseases (POSBINDU PTM), which aims to promote early detection and monitoring of major risk factors. These activities support initial individual health identification, including risk factor assessment and blood glucose screening conducted by trained cadres. Individuals identified with health problems may receive health education, appropriate interventions, and/or referrals to First-Level Health Service Facilities (FKTP). In addition, diabetes mellitus can be controlled through healthy lifestyle modifications, such as maintaining a normal body weight, smoking cessation, regular physical activity, and dietary adjustments based on individual needs. An integrated approach involving community participation, early detection, lifestyle modification, and effective referral systems is fundamental to controlling diabetes mellitus and improving population health outcomes (Kemenkes, 2020).

METHODS

This research is an analytic observational study with a case-control study method with matching sex and age. This study uses secondary data that come from the surveillance reporting system in the Non-Communicable Disease Information System (SI PTM) which comes from surveillance activities in POSBINDU PTM. Furthermore, data selection was carried out from August to October 2022. To maintain the quality of the data used in this study, the researchers established inclusion criteria. The inclusion criteria consisted of respondent data that were completely recorded, including respondent characteristics (age > 15 years and gender), history of non-communicable disease (NCD) risk factors (abdominal circumference, physical activity, fruit and vegetable consumption, alcohol consumption, and smoking history), and availability of blood glucose test results from the NCD Surveillance data of the Yogyakarta City Health Service for June 2022.

The study was conducted by collecting secondary data by matching cases by gender and age group with a comparison of cases and controls of 1:2. The total population aged 15 years and over is 3,021,467 people in the City of Yogyakarta in June 2022 (BPS, 2020). The sample size used is the case-control sample size (Lemeshow,

1991), this research sample size of 507 people was obtained consisting of 169 case groups and 338 control groups. The independent variables studied were age, sex, smoking status, alcohol consumption, fruit and vegetable consumption, physical activity, and abdominal circumference while the dependent variable was blood sugar levels while in the city of Yogyakarta. The control group is respondents with blood sugar levels <200mg/dL. Meanwhile, the case group consisted of respondents with blood sugar levels ≥200 mg/dL (IDF, 2021). The analysis carried out was the *Chi-square* or *Fisher* test by assessing the OR value.

RESULTS AND DISCUSSIONS

A total of 507 respondents met the inclusion criteria. The majority of participants in the case group (Table 1) were female (53,3%), aged 46–55 years, classified as early elderly (52,1%). Most cases also had abdominal obesity (58,6%), were physically inactive (52,1%), and reported inadequate consumption of vegetables and fruits (57,4%).

Table 1. General characteristics of demographics (n=507)

Characteristic	Cases (%)	Control (%)	Total (%)
Age Group (year)			
≥65 seniors	1 (0.6)	2 (0.6)	3 (0.6)
56-65 late elderly	51 (30.2)	102 (30.2)	153 (30.2)
46-55 early elderly	88 (52.1)	176 (52,1)	264 (52.1)
35-45 late adulthood	20 (11.8)	40 (11.8)	60 (11.8)
26-36 early adulthood	7 (4.1)	14 (4.1)	21 (4.1)
17-25 years	2 (1.2)	4 (1.2)	6 (1.2)
Sex			
Female	90 (53.3)	180 (53.3)	270 (53.3)
Male	79 (46.7)	158 (46.7)	237 (46,.)
Belly Circumference			
Central obesity	99 (58.6)	202 (59.8)	301 (59.4)
Not obese	70 (41.4)	136 (40.2)	206 (40.6)
Physical Activity			
No	88 (52.1)	218 (64.5)	306 (60.4)
Yes	81 (47.9)	120 (35.5)	201 (39.6)
Fruits and Vegetable Consumption			
No	97 (57.4)	210 (62.1)	307 (60.6)
Yes	72 (42.6)	128 (37.9)	200 (39.4)
Alcohol			
Yes	0 (0.0)	4 (1.2)	4 (0.8)
No	169 (100.0)	334 (98.8)	503 (99.2)
Smokers			
Yes	30 (17.8)	58 (17.2)	88 (17.4)
No	139 (82.8)	280 (82.8)	419 (82.6)

Source: Primary data, 2022

Based on the data in Table 2, among the various risk factors analyzed among 507 respondents in Yogyakarta, only physical activity demonstrated a statistically significant association with random blood glucose levels (p = 0.009). A higher proportion of individuals in the control group engaged in physical activity (64.5%) compared to those in the case group (52.1%). The Odds Ratio of 0.71 (95% CI: 0.55–0.91) indicates that regular physical activity serves as a protective factor, reducing the likelihood of abnormal blood glucose levels by approximately 29%. Conversely, other variables including age group (p = 1.00), sex (p = 1.00), central obesity based on belly circumference (p = 0.87), fruit and vegetable consumption (p = 0.35), alcohol intake (p = 0.30), and smoking status (p = 0.96) showed no statistically significant correlation with random blood glucose levels in this study population. Therefore, increasing physical activity represents the most crucial lifestyle intervention for blood glucose management in this region.

Table 2. Risk factors of random blood glucose level in Yogyakarta (n=507)

Variables	Case (%)	Control (%)	OR (95% CI)	*p-value*
Age Group (years)				
≥35	161 (95.3)	321 (95.0)	1.044 (0.58-1.87)	1
<35	8 (4.7)	17 (5.0)		
Sex				
Female	90 (53.3)	180 (53.3)	1 (0.78-1.28)	1
Male	79 (46.7)	158 (46.7)		
Belly Circumference				
Central obesity	99 (58.6)	202 (59.8)	0.968 (-)	0.87
Not obese	70 (41.4)	136 (40.2)		
Physical Activity				
No	88 (52.1)	218 (64.5)	0.71 (0.55-0.91)	0.009*
Yes	81 (47.9)	120 (35.5)		
Fruits and Vegetable Consumption				
No	97 (57.4)	210 (62.1)	0,87 (0.68-1.12)	0.35
Yes	72 (42.6)	128 (37.9)		
Alcohol[1]				
Yes	0 (0.0)	4 (1.2)	-	0.30
No	169 (100.0)	334 (98.8)		
Smokers				
Yes	30 (17.8)	58 (17.2)	1.02 (0.74-1.41)	0.96
No	139 (82.8)	280 (82.8)		

Note: *Chi-square test, [1]Fisher test, OR (Odd Ratio), significant if the p-value < 0.05

Association between age and blood sugar levels

Based on the results of the analysis, age is not a risk factor for blood sugar levels (p = 1; OR= 1.04; CI 0.58–1.87). However, age >40 years is a vulnerable age for various degenerative diseases, one of which is diabetes mellitus. Degenerative disease is a disease caused by a decrease in the quality of the body's organ tissue. At the age of> 40 years, insulin production begins to decrease, and the activity of muscle cells also begins to decrease (Roy et al., 2018).

Although this study shows age is not a risk factor. However, age triggers risk factors with a rise in high blood sugar levels (Kibebe et al., 2013). This is because the consumption pattern, lifestyle, physical activity of each individual has different habits (Kemenkes, 2019).

Association between sex and blood sugar levels

Based on the results of the analysis in Table 2, it shows a p value of 1 with OR=1; 95% (CI 0.78−1.28). Gender in this study showed no significant relationship with type 2 Diabetes Mellitus. In line with research (citation) that gender is not associated with the incidence of abnormal sugar levels. This is due to the presence of the hormone estrogen in women compared to men. Where, this hormone is one of the triggers for abnormal sugar levels (Prasetyani and Martiningsih, 2019; Nasution et al., 2021;). But, Milita et al. (2021) which states that there is a significant relationship between gender and the incidence of type 2 diabetes mellitus. High blood sugar levels in women compared to men are influenced by differences in body composition and differences in levels of sex hormones between men and women. In addition, high blood sugar levels that occur in women can be caused by the impact of diabetes experienced during pregnancy, the life expectancy of women is higher, and the rates of hypertension and obesity are more common in women than men (Tim Bumi Medika, 2019).

In women, the hormones estrogen and progesterone have the ability to increase insulin response in the blood. When menopause occurs, insulin response will decrease due to low estrogen and progesterone hormones. Another influencing factor is that women's weight is often not ideal, so this can reduce the sensitivity of the response to insulin. This is what makes women more often affected by diabetes than men. It is also appropriate that the main cause of the large number of women affected by type 2 diabetes mellitus is due to a decrease in the hormone estrogen, especially during menopause (Nasution et al., 2021).

Association between Central Obesity/abdominal circumference with blood sugar levels

Based on the results of the analysis in Table 2, it is known that the *p-value* is 0,87 with (OR = 0.96; 95% CI 0), indicating that there is no significant relationship between abdominal circumference and sugar levels. Abdominal circumference is not related to the incidence of diabetes mellitus (Nasution et al., 2021). However, there is a significant relationship between abdominal circumference and the incidence of diabetes mellitus (Handayani et al., 2018).This difference in results can occur because there are other factors that occur when conducting research to measure.

In the process of entry of sugar into cells, insulin must open the cell door. However, under certain conditions, the insulin receptor is insensitive to the presence of sugar which results in the key and lock process not occurring so that the sugar is still in the blood and causes high blood sugar. This condition is known as insulin resistance and is often associated with obesity or circumference (Nurrahmani, 2015). Circumference status is closely related to diabetes mellitus. Circumference or excess body weight with a body mass index (BMI) ≥ 27 is a risk factor for diabetes mellitus. The results of the 2013-2018 Riskesdas note that the prevalence of Lingkar has increased and is accompanied by an increased prevalence of diabetes mellitus (Nugroho et al., 2019; Kemenkes, 2020;).

Obesity is the most potent promoter of type 2 diabetes (T2DM) and increases the risk of many other metabolic and cardiovascular diseases. It is well known that excess

body fat as well as unfavorable fat distribution including ectopic fat deposition induces a state of chronic inflammation and insulin resistance and impairs insulin secretion (Hauner, 2017). In the Circumference, fat cells that are fat will produce several substances classified as adipocytokines in greater quantities than in a non-fat state. These substances cause insulin resistance. The fat cells lining the abdominal organs produce the most adipocytokines. Therefore, the size of the circumference that has a negative impact on diabetes is determined by measuring the size of the waist circumference (Nurrahmani, 2015).

Circumference is a multifactorial, complex disease and most cases are preventable. Circumference is an associated, complex, multifactorial disease, and most cases are preventable (Bhupathiraju and Hu, 2016). This is reinforced by the results of research conducted by Suwinawati et al. (2020) BMI circumference and high blood sugar levels are caused by a lack of awareness of the body's health condition, lack of physical activity, and not routine health checks at the nearest health care facility. In addition, most of the respondents felt that they were healthy and did not feel that they were actually experiencing Circumference caused by unhealthy eating patterns, such as the habit of consuming high-carbohydrate foods at night.

Association between physical activity and blood sugar levels

It is known that physical activity shows that there is a relationship between physical activity and blood sugar levels during (p = 0.009; OR = 0.71; 95% CI 0.55–0.91). The OR value indicates that someone who does not do physical activity has the potential to experience an increase in blood sugar levels at any time. Between physical activity and the incidence of type 2 diabetes mellitus (Gebang, 2021). Although physical activity is not associated with the occurrence of physical activity (Handayani et al., 2018). However,Physical activity is one of the management programs for type 2 diabetes mellitus for adults. Lack of physical activity is part of the risk factors for diabetes so that for patients with diabetes mellitus, physical activity can reduce the risk of cardiovascular events and can increase life expectancy (Ramadhanisa, 2013). Maintaining physical fitness, improving and maintaining muscle performance is a strategy to control diabetes mellitus through preventive measures. Physical activity and physical exercise are recommended for diabetic patients without complications as an effort to prevent complications. Physical exercise is beneficial for maintaining fitness and can lose weight and improve insulin sensitivity, which will improve blood glucose control (Kemenkes, 2020).

According to Akter et al. (2017), individuals who do not engage in physical activity have a 71% higher risk of elevated blood glucose levels compared to those who are physically active. To achieve optimal health benefits, physical activity should be performed regularly, at least three to four times per week, with a minimum duration of 30 minutes per session. The recommended activity does not need to be strenuous; moderate activities such as brisk walking for 30 minutes or longer are sufficient and meet the criteria for beneficial physical activity. Consistent engagement in physical activity is essential to maintain HbA1c levels within normal ranges (Kong and Cho, 2020).

Regular physical activity is recommended for diabetic patients to help control blood glucose levels, because it will have an impact on HbA1c levels which are not affected by previous physical activity. Infrequent physical activity can result in decreased cell sensitivity to insulin (Cosansu et al., 2018). This theory is supported by the results of research conducted by Azitha et al. (2018)which states that there is no

relationship between physical activity and fasting blood glucose levels in DM patients who come to the Internal Medicine Polyclinic at RSUP Dr. M. Djamil Padang. This is because most of the respondents are elderly and housewives, who do physical activity that is not too strenuous and can be interspersed with rest.

Strenuous physical activity has been shown to reduce the risk of developing diabetes mellitus. This is in line with the research conducted Suprapti (2018) which states that there is a relationship between physical activity in the elderly with the incidence of diabetes mellitus. Elderly with heavy physical activity can reduce the risk of diabetes up to 2,6 times higher than the elderly with light physical activity. During rest, the process of absorbing glucose by the body's tissues requires insulin, whereas in active muscles it is not accompanied by an increase in insulin levels even though the need for glucose increases. This is because when a person is physically active, the sensitivity of insulin receptors in active muscles increases (Suprapti, 2018).

Blood sugar levels > 250 mg/dL are not recommended to excessive exercise because when exercising the body requires more energy. The need for energy in large quantities forces the body to produce energy that come from reserves. Because in diabetics insulin cannot work optimally, the body will take energy from glucose and fat in the liver. Both sources of energy can cause blood sugar levels to rise rapidly (Nurrahmani, 2015).

Association between consumption of fruit and vegetables with blood sugar levels

There is no relationship between fruit and vegetable consumption and the incidence of diabetes mellitus (p = 0.35; OR = 0.87; 95% CI 0.68–1.12). Even though the statistical test results were not significant, it was biologically concluded that people who do not eat fruits and vegetables can experience an increase in blood sugar levels. However, in general, vegetables and fruits are sources of various vitamins, minerals and dietary fiber. Adequate consumption of fruits and vegetables plays a role in maintaining normal blood pressure, blood sugar levels and blood cholesterol and can prevent non-communicable diseases (Ali, 2019). Consuming fiber from vegetables can reduce insulin resistance in the body. Someone who eats foods containing fiber will feel full and be able to delay hunger and can slow down the uptake of glucose in the blood (Fatimah dan Siregar, 2021).

Consumption of fiber foods has been confirmed to be inversely related to the development of type 2 diabetes. Consuming five servings of vegetables and fruit per day (400 g/day) is recommended for a balanced diet as an effort to control diabetes mellitus. Vegetables and fruit play a role in maintaining blood sugar levels because they have antioxidant effects, contain fiber, and magnesium. Antioxidants are useful to counter the harmful effects of reactive oxygen species which are involved in the pathogenesis of diabetes mellitus. Fiber in vegetables and fruit will be fermented, causing an increase in the diversity of intestinal microbes. This diversity of gut microbes is beneficial in insulin production. Meanwhile, magnesium contained in vegetables and fruit acts as a cofactor for regulating blood sugar levels (Wibowowarni et al., 2021; Mao et al., 2021).

A vegetarian diet that is applied early on can prevent diabetes (Olfert and Wattick, 2018). However, there are differences with the results of research conducted Ramadhani et al. (2022) which shows that there is a relationship between the lack of fruit and vegetable consumption and the incidence of diabetes mellitus. Lack of fruit and vegetable consumption is protective because not all types of vegetables can prevent diabetes mellitus. Nurjana and Veridiana (2019) also stated so, so that it is inversely proportional to the recommendation to consume fruits and vegetables to prevent excess

blood sugar levels. This is because some types of vegetables can increase the risk of developing diabetes mellitus if consumed in excess

Association between alcohol consumption and blood sugar levels

The results of the analysis that has been carried out show that the *p-value* is 0.30; OR = none. It is known that alcohol consumption is not a risk factor for blood sugar levels, however the incidence of diabetes mellitus is influenced by behavioral determinants, one of which is alcohol consumption. Several studies state that alcohol can reduce fat oxidation so that it can cause excess fat storage in the body. Alcohol consumption factors affect the incidence of type 2 diabetes mellitus (Pigi, 2017).

Alcohol contains a lot of carbohydrates and calories. Someone who consumes alcohol will find it more difficult to regulate their blood sugar levels. Alcohol can inhibit the liver from releasing sugar into the blood, so that blood sugar levels can decrease. If a patient with diabetes mellitus takes diabetes medication or injects insulin, hypoglycemia can occur due to drinking alcohol. Therefore, alcohol consumption needs to be limited, or avoid drinking alcohol on an empty stomach and blood sugar is dropping. Alcohol can increase blood sugar levels due to the high calorie content of alcohol (Tandra, 2019). reducing alcohol consumption habits in an effort to reduce the risk of DM, namely decreasing blood glucose levels (Pigi, 2017).

A number of epidemiological studies have examined the relationship between alcohol consumption and the development of diabetes mellitus. Among western epidemiological studies, some found no association. The relationship between alcohol consumption and the risk of type 2 diabetes mellitus with the lowest risk in light to moderate drinking. One study showed that frequent alcohol consumption had a consistent protective effect against type 2 diabetes, even when levels of consumption were relatively high (Seike et al., 2008).

Association between smoking status and blood sugar levels

There is no relationship between smoking status and diabetes mellitus. It is known that the *p-value* of smoking is equal to (*p-value* = 0.96; OR = 1,02 CI: 0.740-1.4). Cigarette smoke can increase blood sugar levels. The effect of smoking (nicotine) stimulates the adrenal glands and can increase glucose levels (Sari et al., 2018). According to Ryan (2018) smoking was identified as a risk factor for insulin resistance, which is a precursor to the occurrence of type 2 DM. In addition, smoking can worsen the metabolism of glucose where it can trigger the occurrence of type 2 DM. Smoking habits, amount of cigarette consumption, duration of smoking, and passive smoking with the incidence of blood sugar levels (Fajriati, 2021). Respondents with DM need to reduce their smoking habit in an effort to reduce the risk of DM, namely decreasing blood glucose levels (Pigi, 2017). In 2014 the Surgeon General American stated "That smoking is a cause of type 2 diabetes mellitus that occurs in adulthood and smoking has a 30-40% risk of developing type 2 diabetes mellitus than non-smokers.

CONCLUSIONS

Lack of physical activity significantly increases the risk of abnormal blood glucose levels has the potential to experience blood sugar levels higher than normal with people who do physical activity in the city of Yogyakarta. Abnormal sugar levels are the starting point for Diabetes Mellitus.

ACKNOWLEDGMENTS

The research team would like to thank Kemenristekdikti for funding this research and the Yogyakarta City Health Office for granting permission for this research.

CONFLICT OF INTEREST (special english article)

The author(s) declare that they have no conflict of interest

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