





# The Correlation of Smoking Behaviour, Physical Activity, and Eating Patterns with the Incidence of Impaired Glucose Tolerance in DKI Jakarta in 2018

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**Abstract.** The proportion of Impaired Glucose Tolerance (IGT) in Indonesia has increased in the last 5 years, from 29.9% in 2013 to 30.8% in 2018. IGT tends to be overlooked because it does not have specific symptoms, but if IGT is ignored it will develop rapidly into Type II DM. The purpose of this study was to see the Correlation between smoking behavior, physical activity, and dietary consumption patterns with the incidence of IGT in DKI Jakarta due to the fact that DKI Jakarta is an area with the highest prevalence of DM in Indonesia. Method: This type of research is descriptive quantitative using a cross-sectional approach with data sources from the 2018 Basic Health Research. The dependent variable studied was the incidence of IGT, with independent variables such as smoking behavior, physical activity, and dietary consumption patterns. The research area taken is DKI Jakarta. The Data were collected using a 2018 Basic Health Data individual questionnaire. The data analysis carried out was univariate to describe the frequency and distribution of the variables, bivariate analysis using the chi-square test, and multivariate analysis with regression logistic test. Result: The results of this study show that there was a Correlation between smoking behavior and the incidence of IGT ( $p = 0.018$ ), there was a Correlation between fruit consumption and the incidence of IGT (0.047), there was no Correlation between physical activity and the incidence of IGT ( $p = 0.391$ ), and there was no Correlation between consumption patterns of sweet foods, sweet drinks, and vegetables with the incidence of IGT ( $p = 0.489$ ), ( $p = 0.326$ ), ( $p = 0.509$ ), ( $p = 0.451$ ). Conclusion: In this study, the only variables related to the incidence of IGT were smoking behavior and fruit consumption patterns. Variables of physical activity, consumption patterns of sweet foods, sweet drinks, soft drinks, and vegetable consumption are not associated with the incidence of IGT. For further researchers, it is necessary to review and study the variables and research areas that will be taken when using secondary data.

**Keywords:** impaired glucose tolerance · smoking habit · physical activity · dietary consumption pattern

## 1 Introduction

Diabetes Mellitus (DM) is a non-communicable disease that needs special attention because it has a high prevalence globally and nationally because Indonesia occupies the 7th position for the population with the most DM [1]. The natural history of the disease has a middle phase called the condition of IGT which is when blood glucose levels exceed normal limits but cannot be diagnosed as DM [2]. IGT can be diagnosed through glucose loading, IGT can be diagnosed through glucose challenge test. If the glucose has a value of 140–199 mg/dL after 2 h of glucose liquid (with certain amount of glucose) consumption, then it can be diagnosed as IGT [3]. Patients usually do not realize this condition due to its asymptomatic nature, even though IGT condition can develop into type II DM in just a few years if it is being ignored [4, 5] The incidence of IGT in Indonesia is also high and has increased from 29.9% in 2013 to 30.8% in 2018 [6, 7].

One way to control the rate of IGT into Type 2 DM is to start a healthier lifestyle such as by quitting smoking, doing physical activity, and maintaining a healthy diet [8]. Having a smoking habit is proven to increase blood glucose levels and insulin resistance, while most of the Indonesian population are active smokers, especially in the male population, which is 62.9% [3, 9]. Tweed's research proves that the nicotine content in cigarettes increases insulin resistance and has a significant Correlation with glucose intolerance [10]. Performing physical activity has been proven to improve the quality of blood vessels and aspects like glucose tolerance and insulin sensitivity [11]. Research conducted by Defrenzo and Ghani proves that doing physical activity reduces the rate of progression IGT to DM Type II [12]. Beside that, regulating healthy eating patterns is also important to prevent the rate of progression, because having an unbalanced diet will trigger obesity which causes insulin resistance and results in increased blood glucose levels [13].

The entire area of DKI Jakarta is urban areas. Urban areas have a close Correlation with lifestyle changes due to the influence of globalization, especially on food consumption patterns and physical activity, causing more people with obesity than in urban areas [14]. Apart from being the area with the highest prevalence of DM in Indonesia in 2018, it was also recorded that the population of DKI Jakarta had low physical activity. It was estimated that 47.8% of the population of DKI Jakarta do not do physical activity according to the recommendations [7]. In addition, as many as 25.75% from the population aged 15 years in DKI Jakarta are smokers [15]. DKI Jakarta residents are also known to have a pattern of consuming sugar, salt, and fat foods that exceed the limits set by Minister of Health Regulation No. 30 of 2013 and there are only a few people who consume fruits and vegetables, It is estimated that 90% of the population of DKI Jakarta consumes less than 5 portions of fruit and vegetables per day [4, 16].

Research related to the analysis of risk factors for the incidence of diabetes has been widely carried out, but it is rare to find studies that discuss risk factors for the incidence of prediabetes, especially on the variables of smoking behavior, physical activity, and eating patterns with the incidence of IGT using secondary data from Riskesdas 2018 Given the high prevalence of IGT in Indonesia, it is very likely that there will be an increase in the prevalence of DM and other Non-Communicable Diseases (PTM) due to IGT because so far the IGT group in Indonesia has not received attention from stakeholders, but only

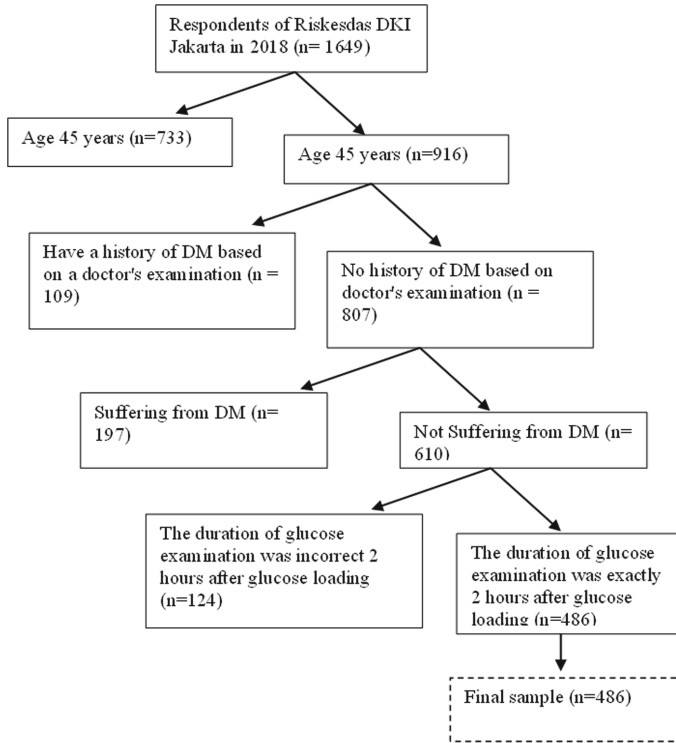
the diabetes group that has received intervention [17]. Based on this background, this study aims to determine the Correlation between smoking behavior, physical activity, and food consumption patterns with the incidence of IGT in DKI Jakarta.

## 2 Method

The research design used was an analytic epidemiological design with a cross sectional approach. This research is a follow-up analysis of the 2018 Riskesdas data. To carry out further analysis with the Riskesdas data, it is necessary to submit a data request proposal that contains the background of the research to be carried out and the data variables to be studied. The data collection method used in this study was the 2018 Riskesdas Individual Questionnaire.

In this study, the dependent variable to be studied is the incidence of IGT in DKI Jakarta, while the independent variables include smoking behavior, physical activity, and food consumption patterns which include consumption patterns of sweet foods, sweet drinks, soft drinks, fruit, and vegetables. The IGT category in this study was divided into two, namely IGT and not IGT. Respondents with glucose measurement results of 140–199 mg/dl after 2 h passed from consuming 75 g of glucose liquid were included in the IGT category, while respondents with glucose levels < 140 mg/dl were included in the non-IGT category. In the category of smoking behavior, the respondents studied were active smokers. People who are smoking or who have had a history of smoking are included in the smoking category. While respondents who have never smoked at all is categorized into non-smoking behavior. In the category of physical activity, respondents who have a calorific value of > 600 METminutes per week are included in the category of moderate physical activity, while respondents who have a caloric value of < 600 METminutes/week are categorized as respondents with less activity. In the pattern of food consumption, respondents with the behavior of consuming sweet foods, sweet drinks, and soft drinks as much as 1 time per day, 1 times per day, or 3–6 times per week are included in the high risk consumption pattern, while for respondents with consumption 1–2 times per week and < 3 times per month is included in the low risk consumption pattern. In the pattern of fruit and vegetable consumption.

Research data management is carried out after obtaining data of March-May 2021 from the Health Research and Development Agency (Balitbangkes). The population of this study is the entire population of DKI Jakarta who are Riskesdas Respondents in 2018 with the sum of 1,649 respondents. The method used is the Probability Proportional to Size method using Linear Systematic Sampling, with Two Stage Sampling. The technique was continued by adjusting the exclusion and inclusion criteria determined by the researcher. The exclusion criteria were determined in the form of respondents with DM, respondents with a history of DM based on the results of a doctor's examination, and respondents with an inappropriate glucose examination time of 2 h after glucose loading was carried out, while the inclusion criteria in this study included residents of DKI Jakarta who were registered as Riskesdas respondents in 2013, 2018 and are over 45 years old and who have complete data. After determining the exclusion and inclusion criteria, a sample of 486 respondents was obtained.



**Fig. 1.** Data cleaning flow

Data management carried out includes data filtering which aims to adjust the data obtained with the required data, then cleaning the data to remove missing data and pre-determined exclusion criteria, and re-coding to categorize research variables according to the operational definitions that have been made. The data cleaning flow is shown in Fig. 1.

After data management was carried out, this study was analyzed using univariate analysis to see distribution and frequency, bivariate analysis was carried out by chi square test, and multivariate analysis was carried out by logistic regression test.

### 3 Results

The characteristics of respondents in this study can be seen in Table 1.

Table 1 illustrates that the proportion of respondents based on gender and age characteristics is the largest group of female respondents at 62.3% or 303 respondents and groups of respondents aged 45–55 years at 59.9% or 291 respondents. As for the characteristics of the area where they live, 100% of the respondents live in urban areas. The largest proportions in the study variables were the group that did not experience IGT (55.1%), did not smoke (64%), the group had sufficient physical activity (65.8%), the high risk sweet food consumption group (50.8%), the group consuming sugary drinks is

**Table 1.** Characteristics of respondents and research variables

Variable	n	%
<b>Gender</b>		
Man	183	37.3
Woman	303	62.3
<b>Age</b>		
45–55 years old	291	59.9
56–65 years old	139	28.6
66 years old	56	11.5
<b>Residential Area</b>		
Urban	486	100
<b>IGT incident</b>		
No IGT	268	55.1
IGT	218	44.9
<b>Smoking Behavior</b>		
Do not smoke	311	64.0
Smoke	175	36.0
<b>Physical Activity</b>		
Enough physical activity	320	65.8
Lack of physical activity	116	34.2
<b>Pattern Consumption of food</b>		
Consumption of low-risk sweet foods	239	49.2
Consumption of high-risk sweet foods	247	50.8
Consumption of low risk sugary drinks	132	27.2
Consumption of sugary drinks is high risk	354	72.8
Consumption of low risk soft drinks	473	97.3
Consumption of high-risk soft drinks	13	2.7
Consumption of fruit as recommended	145	29.8
Consumption of fruit is not as recommended	341	70.2
Consumption of vegetables as recommended	301	61.9
Consumption of vegetables is not as recommended	185	38.1

high risk (72.8%), the group is consuming soft drinks at low risk (97.3%), the fruit consumption group is not as recommended (70.2%), and the group is consuming vegetables as recommended (61.9%).

Based on Table 2, the largest proportion of groups experiencing IGT are the non-smoking group (48.9%), the moderate physical activity group (46.3%), the low-risk

sweet food consumption group (46.4%), the high-risk sweet drink consumption group. Low (48.5%), high risk soft drink consumption group (53.8%), fruit consumption group as recommended (51.7%), vegetable consumption group not as recommended (47%). Based on the chi-square test that has been carried out, the variable that has a significant Correlation with the incidence of IGT is smoking behavior with a p value = 0.018, with a Odds Ratio (OR) 0.633, which means that respondents with smoking behavior have a risk of experiencing IGT 0.63 times greater than respondents who do not smoke. The OR value < 1 indicates that smoking is a protective factor against the incidence of IGT. In addition to smoking behavior, fruit consumption patterns also have a significant Correlation with the incidence of IGT, indicated by the p value = 0.047 with an OR value of 0.674, which means that respondents with fruit consumption patterns that are not as recommended have a risk of experiencing IGT 0.67 times greater than respondents who consume fruit as recommended. Although it has a significant Correlation with IGT, the pattern of fruit consumption is a protective factor because it has an OR value < 1. Other variables such as physical activity, consumption patterns of sweet foods, sugary drinks, soft drinks.

After the logistic regression test, the variable that still influences the incidence of IGT is smoking behavior which has a p-value of 0.021 and an OR of 0.640. Respondents with smoking behavior have a risk of experiencing IGT 0.64 times greater than respondents who do not smoke. Although in the chi-square test fruit consumption had a significant Correlation with the incidence of IGT, the logistic regression test did not have a significant Correlation with the incidence of IGT so that the variable was excluded (Tables 3 and 4).

After the fruit consumption variable was removed, the p-value on the smoking variable was 0.018 and the OR was 0.633, which means respondents with smoking behavior have a risk of experiencing IGT 0.63 times greater than respondents who do not smoke.

## 4 Discussion

### 4.1 The Correlation of Smoking Behavior with the Incidence of IGT

The results of data analysis stated that in this study smoking behavior has a significant Correlation with the incidence of IGT. The smoking variable in this study was only the category of active smokers. This is in line with Chang's (2012) research which proves that smoking is one of the risk factors for IGT because smoking can increase blood glucose and increase insulin resistance [18]. Cigarette exposure can have an effect on insulin action because the nicotine content in cigarettes can cause an increase in insulin resistance which has a significant Correlation with glucose intolerance and diabetes [10]. In addition to nicotine, there are other ingredients in cigarettes, namely tar and carbon monoxide. Tar that settles in the body of smokers can increase free radicals that affect the release of cortisol. The hormone cortisol that is released continuously can increase blood glucose levels and interfere with insulin work [19]. In addition, the substances contained in cigarettes increase levels of the hormones epinephrine and norepinephrine which affect the sympathetic nerves which can increase the rate of gluconeogenesis and glycogenolysis [20, 21]. Another study conducted by Mosson (2017) also showed

**Table 2.** Cross-tabulation between smoking behavior, physical activity, and food consumption patterns with the incidence of IGT

Variable	IGT incidence				p-value	OR	95% CI
	Yes		No				
	n	%	n	%			
<b>Smoking Behavior</b>							
Do not smoke	152	48.9	159	51.1	0.018	0.633	0.434–0.924
Smoke	66	37.7	109	62.3			
<b>Physical Activity</b>							
Enough	148	46.3	172	53.8	0.391	0.847	0.580–1.237
Lack	70	42.2	96	57.8			
<b>Consumption of sweet food</b>							
Low-risk	111	46.4	128	53.6	0.489	0.881	0.616–1.260
High-risk	107	43.3	140	56.7			
<b>Consumption of sweet drinks</b>							
Low-risk	64	48.5	68	51.5	0.326	0.818	0.548–1.222
High-risk	154	43.5	200	56.5			
<b>Consumption of soft drinks</b>							
Low-risk	211	44.6	262	55.4	0.509	1.449	0.480–4.376
High-risk	7	53.8	6	46.2			
<b>Fruit consumption</b>							
Adequate	75	51.7	70	48.3	0.047	0.674	0.456–0.996
Not adequate	143	41.9	198	58.1			
<b>Vegetable consumption</b>							
Adequate	131	43.5	170	56.5	0.451	1.152	0.798–1.664
Not adequate	87	47.0	98	53.0			

**Table 3.** Multivariate Analysis for Smoking Behavior and Fruit Consumption Variables with IGT Incidence

Variable	p-value	OR	95% CI
Smoking Behavior	0.021	0.640	0.438–0.936
Fruit Consumption	0.058	0.684	0.462–1.012

that active smokers have an increased risk of developing Type 2 DM compared to non-smokers [22]. Another study conducted by Sukenty (2018) also stated that smoking status had a significant correlation with prediabetes [23].

**Table 4.** Logistic Regression Test for Smoking Behavior Variables with IGT Incidence

Variable	<i>p-value</i>	OR	95% CI
Smoking Behavior	0.018	0.633	0.434–0.924

However, smoking behavior in this study had an inverse Correlation with the incidence of IGT. A person who quits smoking can experience metabolic disorders such as increased body weight and fat mass in the first three months after quitting smoking, even followed by fasting hyperinsulinemia [24]. The risk of DM will increase in the group of people who have just quit smoking, although the risk will decrease as the duration of smoking cessation increases [24].

Respondents who experienced IGT in this study were more common in the non-smoking group because the majority of respondents in this study did not have smoking behavior. This is in accordance with research conducted by Nwaokoro (2014) which states that the incidence of IGT is more common in respondents who do not smoke compared to respondents who smoke or have smoked [25]. Research conducted by Seowondo and Pramono (2011) also states the same thing [26]. Rusdina (2015) in his research also states that respondents with non-smoking behavior actually have a greater prevalence of IGT than those who smoke or have smoked, this is because respondents who are included in the smoking category are under 45 years old and are still in the productive age group. Do not have a risk of IGT or the risk of getting IGT is still low [27].

Although several studies have stated that the incidence of IGT is more common in the non-smoking group, it does not mean that smoking provides a lower risk of IGT because IGT is a multicausal disease, so that the occurrence of IGT is not caused by one factor alone [27].

#### 4.2 The Correlation of Physical Activity with the Incidence of IGT

Besides smoking, physical activity is also a risk factor for IGT. In this study, the respondent's physical activity was calculated based on the number of calories expended. The number of calories can be seen from the results of multiplying the time and duration of physical activity with the Physical Activity Ratio (PAR) in accordance with the International Physical Activity Questionnaire (IPAQ). Respondents with activities that have total calories > 600 METminutes/week are categorized as moderate physical activity. Meanwhile, low-intensity activities with total calories < 600 METmin/week are categorized as less physical activity.

According to previous research, sufficient physical activity is considered capable of improving all aspects of the body, including improving glucose tolerance and also increasing insulin sensitivity, as well as converting glucose into energy for the body [28, 29]. Research conducted by Nikmah and Danny stated that respondents who did sufficient physical activity had lower leptin levels than respondents who did less physical activity. Lower leptin levels mean that respondents who do sufficient physical activity can reduce the risk of continuing IGT to type 2 diabetes because leptin levels in the body have a Correlation with an increase in type 2 diabetes [30].



The group of respondents in this study that has a larger proportion is the group of respondents with sufficient activity, which is 65.8% or 320 respondents. In this study, there was no significant Correlation between physical activity and the incidence of IGT because it had a  $p$  value  $> 0.05$  ( $p = 0.391$ ). Physical activity was not statistically associated with the incidence of IGT. This is because the respondent group with sufficient activity is the largest proportion of respondents, in addition, the data related to physical activity obtained is the result of recalling the respondent's activities not only specific to sports activities, thus allowing memory bias to occur. From the data that has been obtained, it is also not explained in detail what types of physical activity the respondent does, so that the calculation of the number of calories of physical activity that has been carried out may not show a calculation that is in accordance with the conditions in the field.

The results of this study are in line with research conducted by Nurhidayati (2017) which states that physical activity does not have a significant Correlation with hyperglycemia. ( $p$ -value = 0.969) [31]. Hyperglycemia is a state of glucose levels exceeding normal limits and occurs when glucose tolerance is impaired. This research is also supported by research conducted by Agustina (2017) which states that there is no significant Correlation between physical activity and the incidence of GDPT (Interrupted Fasting Blood Sugar) in LPP RRI South Jakarta employees in 2017 ( $p$ -value = 0.238). GDPT has the same cause as IGT, which is caused by insulin resistance and malfunctioning of pancreatic beta cells [32–34]. Another study conducted by Mayawati (2017) also stated that physical activity was not related to blood glucose levels as indicated by the  $p$  value = 0.127 [35].

While different results were found in the study of DeFronzo (2011) which stated that doing moderate-intensity physical activity 4 times a week can reduce the development of IGT into Type 2 DM [12]. Research conducted by Anani (2012) also states that physical activity has a Correlation with blood glucose levels ( $p$ -value = 0.012). Physical activity is also considered capable of reducing insulin sensitivity, improving lipid profiles, and reducing abdominal fat levels [36]. In addition, if physical activity increases, it will reduce the risk of non-communicable disease (NCD) by 6–10%, especially for the risk of CHD, type 2 DM, breast and colon cancer and increase life expectancy [37]. However, it should also be noted that excessive and extreme physical activity can also have an effect on mitochondrial function where changes in mitochondrial respiration have a Correlation with changes in glucose tolerance [38]. Intense and excessive physical activity can attenuate the gluoregulatory response to intense exercise despite increased skeletal muscle glycogen stores [38]. Bird and Hawley research also states that physical activity, light activity with a longer intensity is considered more effective in increasing insulin sensitivity compared to doing more strenuous activities whose calorie expenditure is calculated to be equivalent [39].

### **4.3 Correlation Between Food Consumption Patterns and the Incidence of IGT**

One way to control the development of DM is to control food consumption patterns. In this study, the food consumption patterns studied included: consumption of sweet foods, consumption of sugary drinks, consumption of soft drinks, consumption of fruit, and

consumption of vegetables. Categorization of food consumption patterns studied refers to the Semi Quantitative Food Frequency (SQFF).

The pattern of consumption of sweet foods, sugary drinks, and soft drink included in unhealthy consumption patterns because these foods have high sugar content which in the long term will increase glucose in the blood so that it can trigger the development of Type 2 DM [40]. Types of sugar are not only found in sugar cane and palm trees, but there are other types such as fructose and sucrose. The content of sucrose is usually found in overripe fruit, honey, or soft drinks. Fructose content has a close Correlation with glucose intolerance [41]. Soft drinks contain a high average fructose content, which is around 55% in each serving [42]. In addition, foods with excess sugar content will also encourage obesity because sweet foods are considered to cause excessive consumption and lead to weight gain [43]. In May's research, it was also stated that flies that consumed excess sugar experienced a decrease in the sensation of sweetness, so they consumed excess too. This is what causes the possibility of obesity, while obesity is a risk factor for IGT because it can cause insulin resistance and decreased insulin sensitivity [44, 45].

Research conducted by Astuti (2018) states that consumption of sweetened drinks has a significant Correlation with the incidence of Type 2 DM (p-value = 0.034). Research conducted by Murti (2016) also has similar results, namely there is a Correlation between sugar consumption habits and the incidence of DM in the working area of the Leyangan Health Center (p-value = 0.013) with an OR of 3.9 which means people with sugar consumption habits are at risk of 3.9 times greater than those who do not consume [46]. Research conducted by Yunjin (2017) stated that female consumption of soft drinks 4 servings/week has been shown to increase the risk of metabolic syndrome (p-value = 0.024) and has an OR of 1.97, which means that female respondents who consume soft drinks 4 servings/week have a risk of metabolic syndrome 1.97 times compared to those who rarely consume. The metabolic syndrome itself includes high glucose levels, diabetes, and abdominal obesity [47].

However, this research is inversely proportional to the research that has been done, this is because researchers only focus on the frequency of consumption and ignore the amount of sugar consumed in each serving. In addition to this, data collection related to the consumption of sweet foods, sugary drinks, and soft drink also done through food recall so as to allow the occurrence of memory bias. This study is supported by He (2018) research which states that consumption of sugary drinks has a Correlation with weight gain, but does not have a significant Correlation with hypertension, metabolic syndrome, and blood glucose levels [48]. In addition, the research conducted by Wicaksono (2011) also had similar results, namely the consumption of sweet foods or drinks did not have a significant Correlation with the incidence of Type 2 DM (p-value = 0.292) [49]. Anjangsari's research (2015) also stated that soft drink consumption did not have a significant Correlation with an increase in blood glucose (p-value = 0.477) [50].

One way to slow down the rate of development of type 2 diabetes and control blood glucose levels is fiber consumption. Fruits and vegetables are easy-to-find sources of fiber [51]. In addition to containing fiber, fruits and vegetables also contain potassium which when consumed in sufficient quantities can lower blood glucose levels [52]. Research conducted by Fatimah and Siregar (2020) states that fruit consumption can inhibit the increase in glucose because fruits can inhibit the enzyme gluconeogenesis, one of the enzymes that can increase glucose levels [53]. In addition, research conducted

by Kristenta (2015) also states that consumption of fruits and vegetables has a significant Correlation with the incidence of Type 2 DM (p-value = 0.000) with an OR of 2.91, which means that respondents who consume less fruits and vegetables have a higher risk of developing diabetes. Experiencing Type 2 DM 2.91 times compared to respondents who consume enough fruits and vegetables [54]. Similar to the two studies above, Idris' research (2014) states that fruit consumption has a Correlation with controlling blood sugar levels. Fruits have a relatively lower glycemic index when compared to other high-fiber foods, this can help control appetite because it creates a feeling of fullness, so it doesn't cause excess energy [55].

Although in this study there was a statistically significant Correlation between fruit consumption and the incidence of IGT, the OR value obtained was  $< 1$  which means fruit consumption is a protective factor against the incidence of IGT. This can happen because respondents who consume fruit as recommended and experience IGT have almost the same percentage as respondents who consume fruit not as recommended but do not experience IGT. In this study also only looked at the frequency of fruit consumption per day without regard to the type of fruit and how many servings of fruit were eaten because there were several fruits that contain high sugar and carbohydrates [56]. Examples of fruits with high sugar content are manganese and bananas which contain 15% sucrose [43]. In addition, there are also fruits such as grapes, oranges, sapodilla, and durian which should be avoided because they are included in the fruit that has a sweet taste [57]. Research conducted by Budiman (2019) stated that giving watermelon in the form of pieces or juice in the morning can increase blood glucose levels with an average increase of 50 mg/dl. This is because watermelon contains simple carbohydrates in the form of fructose. The content of fructose is absorbed more quickly in the body so that it can easily increase blood glucose levels [57].

Respondents who consume vegetables according to the recommendations in this study are more than those who do not follow the recommendations because people in general find it easier to consume vegetables because vegetables are easy to find and the price is affordable for all levels of society [53]. However, the results of this study stated that vegetable consumption did not have a Correlation with the incidence of IGT. This can happen because this study only looked at the frequency of consumption of vegetables in one week without looking at the type of vegetables, portions, and the amount of intake consumed. In addition, data retrieval in this study was carried out through food recall, thus allowing memory bias to occur. This study is in line with research conducted by Ali (2019) which states that vegetable consumption does not have a significant Correlation with the incidence of Type 2 DM as indicated by the p value = 0.140 [58]. In addition, research conducted by Fatimah (2020) also states that vegetable consumption is not associated with the incidence of Type 2 DM [53].

## 5 Conclusion

Based on the research that has been done, it can be concluded that smoking behavior that had a significant correlation with IGT. Physical activity variable, the pattern of consumption of sweet foods, sweet drinks, soft drinks, and vegetable consumption did not have a significant correlation with the incidence of IGT in DKI Jakarta. The DKI

Jakarta government is expected to continue to increase preventive efforts in the pre-diabetes group through periodic health screenings so that people who are at risk of experiencing DM can be prevented by changing their lifestyle to become healthier so that the rate of development of Type 2 DM in DKI Jakarta can be reduced. The public is expected to be more aware of the condition of pre-diabetes by routinely checking blood glucose levels because the condition of pre-diabetes does not have significant symptoms, especially for people who have an unhealthy lifestyle. The next researcher if using secondary data is expected to review the variables to be studied as well as the points to be taken in the questionnaire, besides that it is also necessary to review the research area that will be used.

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