Chapter

Infarct Stroke and Blood Glucose Associated with Food Consumption in Indonesia

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Abstract

Stroke is the primary cause of death in adults. It is predicted that the death caused by stroke will increase twice in the next 30 years. In Indonesia, stroke is one of the diseases of the circulatory system, which has been taking the first place of causing death since 2007. Indonesia has rice as the main type of daily food consumed, which has higher glycemic index than other sources. This study aims to find the risk of blood glucose level that determines the incidence of infarct stroke. There were 164 patients enrolled in this study, 82 patients in each stroke and not stroke group. The blood examination is using the enzymatic method, which is the hexokinase method. The results of research revealed that indicators of high blood glucose level were found in infract stroke incidence, including casual blood glucose, fasting blood glucose, 2-h postprandial blood glucose, and glycated hemoglobin. These four indicators were found in a higher level in the infarct stroke than the non-stroke group. Other epidemiological studies have shown that diabetes is a risk factor for stroke. Therefore, education about food selection should be a priority in the effort to prevent infarct stroke and diabetes mellitus in Indonesia.

Keywords: infarct stroke, cerebrovascular disease, blood glucose, diabetes, tobacco use, Indonesia

1. Introduction

Stroke was previously assumed to occur in developed countries only, as the third leading cause of death and is responsible for 5.5 million deaths every year [1, 2] However, it is actually uncommon to be found in Southeast Asian countries [3–5] or other countries with low and middle income [6].

Stroke is the primary cause of death and disability in the world, whose cost needed for post-stroke treatment and care is quite pricey. In 2016, stroke was the second leading cause of death globally (5.5 million deaths) after ischemic heart disease [2]. In South Asian countries including India, Pakistan, and Bangladesh, as well as developing countries in Southeast Asia, such as Cambodia, Indonesia, Laos, and Malaysia, the stroke incidence is increasing. However, since these developing countries do not have inadequate health facilities, the mortality rate caused by this disease is high and the number of persons with disabilities caused by this disease also increases [3, 7–9].

Stroke is the leading cause of death in adults. The death caused by stroke is predicted to increase twice in the next 30 years [10]. A previous research project carried out by

Carandang (2006) discovered that approximately 62% of all stroke cases were atherothrombotic infarcts [11]. Meanwhile, according to Puthenpurakal [12] about 85% of stroke cases are ischemic stroke or infarct stroke, while the remaining (15%) are hemorrhagic stroke. Global data issued in 2016 also gave similar results, in which 84.4% of stroke incidence were ischemic stroke [2]. Stroke with ischemic health diseases (IHD) was the leading cause of deaths attributable to tobacco use as a risk factor [13].

According to Basic Health Research (RISKESDAS) that was conducted in Indonesia in 2007, it was revealed that stroke was the leading cause of death by 15.4% [14]. In the age group of 45 to 54 years old, stroke is the leading cause of death in urban areas and in men. Meanwhile, in the age group of 55 to 64 years old, this disease is the leading cause of death in both urban and rural areas as well as in both male and female [14]. Martini et al. [15] revealed that 76% of stroke incidence in a hospital that has been a tertiary referral in the last 10 years was ischemic stroke or infarct stroke. Furthermore, there was also an increase of stroke incidence in 2013 compared to 2007, which was 12.1 and 8.3% [14, 16]. Meanwhile, the stroke incidence in 2018 was 10.9 per mile [17].

Previous study carried out by Pinto et al. showed that hypertension was commonly found in lacunar infarct stroke and large artery atherosclerosis in diabetic patients [18]. Therefore, it indicates that hypertension is a co-factor that determines lacunar stroke in diabetic patients. This is in accordance with the statement made by Harry Keen three decades ago that both high blood glucose level and high blood pressure damage blood vessels, especially the small blood vessels (microvascular). Meanwhile, research conducted by Kisella et al. [19] claimed that hypertension comorbidity was not a significant risk factor for the stroke infarct incidence in African Americans (OR = 1.3 95% confidence interval [CI]: 0.9–1.7), yet it was a significant risk factor for the infarct stroke incidence in Caucasian people (OR = 1.6, 95% CI: 1.4–1.9). About 35–42% of all infarct stroke incidences in both African Americans and Caucasians are related to diabetes alone or in combination between diabetes and hypertension. The risk of stroke in hypertension was 1.46 (95% CI: 1.07–1.99) as the sole risk factor [20]. Hypertension is the most common risk factor found in Asia 1 [3, 4, 21, 22]. Data from one of the community-based surveys in Indonesia, which is Sleman Health and Demographic Surveillance System (HDSS) in 2016, found a high prevalence of stroke that was related to the increasing age, hypertension, and diabetes mellitus [9].

When diabetes mellitus (DM) is the sole factor, then DM also increases the risk of infarct stroke [23, 24]. Furthermore, the risk of infarct stroke is 2.5 (95% CI: 2.0–3.2) in all types of DM. According to the type of diabetes mellitus, the risk of infarct stroke is 7.9 times (95% CI: 5.1–12.2) in DM type 1 and 3.0 times (95% CI: 2.6–3.4) in DM type 2. Meanwhile, based on the duration of suffering from DM type 2, infarct stroke risk increases by 1.7 times when the duration of illness is less than 5 years and 3.2 times when the duration of illness is within 10–14 years [25]. Diabetes patients have a higher risk ([OR] 1.33, 95% CI: 1.18–1.5) of suffering from ischemic stroke than hemorrhagic stroke (OR 0.72, 95% CI: 0.6–0.877). In addition, the combination of infarct stroke and DM affects younger people more than infarct stroke without DM. The risk of infarct stroke is more common in white DM patients [26]. According to research conducted by Kaarisalo et al. [27], infarct stroke has a tendency to occur more frequently in people with impaired glucose tolerance (GTG) than in people with normal blood glucose levels, although the difference was not significant [28]. In addition, several studies have estimated that approximately 20–33% of hospitalized patients with acute stroke have diabetes [29, 30]. This is strengthened by the results of the research conducted at General Hospital of Haji Adam Malik Medan Indonesia that diabetes had a relationship with the prevalence of stroke ($p < 0.05$). The risk of stroke was 1.34 times higher in diabetes than those without diabetes [30].

Stroke can occur in all age groups but mostly occurs at the age above 55 years old; thus, age is a strong determinant of infarct stroke incidence [9, 31–33]. Many factors cause stroke. An individual may have more than one risk factor, whether the risk factor is a risk factor that is supported by strong evidence (level of evidence A) or less strong evidence (level of evidence C), or whether these risk factors can be modified or cannot be modified, or whether these risk factors are controlled or not.

High blood glucose level can cause complications on blood vessels such as microangiopathy (eye, kidney, and nerve disorders) and macroangiopathy (stroke and heart problems). If the blood glucose is excessive, then glucose will bind to proteins, including blood vessel wall cells. These bonds will damage the structure and function of blood vessels. The damage or complications that occur cannot be reversed and the process can only be stopped or slowed down [34]. Furthermore, hyperglycemia increases oxidative stress, which causes pathological processes in diabetic complications. Overproduction of reactive oxygen species (ROS) induced by hyperglycemia will activate five pathogenic pathways that contribute to endothelial dysfunction and diabetes complications, and those are (1) polyol pathway; (2) the increase of formation of advanced glycation end products (AGEs); (3) the increase of receptor expression for AGEs; (4) activation of protein kinase C isoforms; and (5) over-activity of the hexamine pathway. Vasculopathy that is induced by chronic hyperglycemia also results in accelerated atherosclerosis in diabetes. Therefore, a higher prevalence and incidence of cardiovascular disease including stroke are common in the diabetic patients [35, 36]. Improper diabetes control also increases the short- and long-term morbidity and mortality associated with stroke and significantly increases the recurrent risk of stroke [35].

Based on the doctor diagnosis, the prevalence of diabetes in Indonesia population has increased from 2007 to 2018. This can be seen from the results of Basic Health Research (RISKESDAS) [16], which increased from 1.5% in 2007 to 2.0% in 2018. Such condition shows that serious problems still occur related to unresolved diabetes. Meanwhile, the prevalence based on the age increased from 2007 to 2018. In this case, the age category was divided into seven groups and the highest prevalence was shown by the age group of above 55 years old and this figure was related to insulin resistance.

Age is a risk factor for diabetes [37]. Based on the results of the research aforesaid, the older age group suffers from DM more. The increasing prevalence of DM that includes metabolic diseases at the old age can be directly related to the aging process or indirectly through several other DM risk factors such as central obesity, mitochondrial dysfunction, FFA and lipid metabolism disorders, inflammation, cell dysfunction, insulin resistance, and metabolic syndrome (**Figure 1**) [38]. The purpose of this study is to find the factor that increases the risk of infarct stroke related to the blood glucose level of Indonesian people.

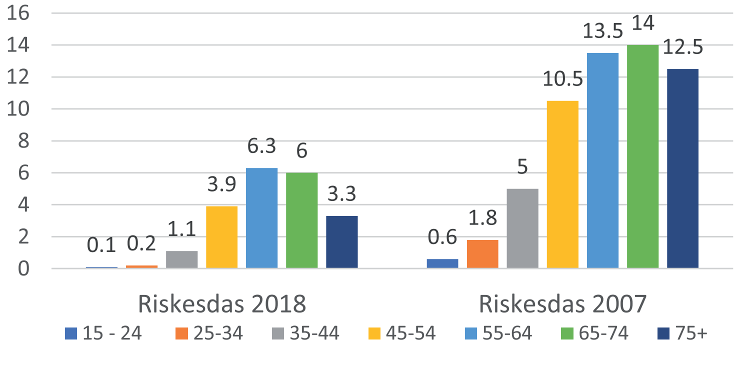

Figure 1.
Prevalence of diabetes mellitus among people age 15 years old and over in Indonesia.

2. Food consumption in Indonesia

Indonesia is the third largest sugar consumer in Asia after India and China. Indonesian people consumption of sugar is slightly higher (5%) than the total energy and when combined with the sugar contained in beverages such as soft drinks, the content will be even higher [39].

Basic Health Research (RISKESDAS) that was conducted in 2018 showed that there were 40.1 and 60.27% of Indonesian people at the age of above 3 years old who consumed sweet foods and beverages once a day [40]. Meanwhile, previous research in 2007 and 2013 found that the consumption of sweet foods was still quite high, although it decreased from 65.2 to 53.1%.

In this case, children at the age group of 3–9 years old have the highest percentage (above 50%) of consuming sweet foods once a day. Furthermore, about 98.4% of Indonesian teenagers at the age of 13–18 years old consumed nutritious foods including fruits and vegetables insufficiently (<400 g/day) [41]. The prevalence of overweight in Indonesia is the highest among adults by 8% of men and 29% of women suffering from central obesity [42]. Therefore, concern needs to be provided to the quality of community diet needs and energy adequacy, especially among teenagers and children who need nutritional intake in the growth process.

Basic Health Research (RISKESDAS) in 2007, 2013, and 2018 was conducted concerning the food consumption pattern of Indonesian people as presented in **Figure 2**. The prevalence of sweet foods and drinks consumption once a day was 65.2% in 2007, which then decreased to 53.1% in 2013. Furthermore, the consumption of sweet food for once a day also decreased to 40.1% in 2018, yet the consumption of sweet beverages once a day increased to 61.27%. In addition, the consumption of soft drinks or carbonated drinks was 2.2% (**Figure 3**) [14, 16, 17, 40].

Several other studies have also revealed that Indonesian adults insufficiently consumed protein, fruits, and vegetables, but consumed fast food and sodium excessively [41]. Another study that has been conducted in Central Java, Indonesia, also showed that dietary patterns were associated with increased consumption of soft drinks, snacks, and various animal products [43]. Another study was further conducted in Jakarta showing that the daily food consumption of the observed population reached 1868–2334 g/capita/day. The total intake of added sugar in the different groups of respondents ranged between 34.9 and 45.9 g/capita/day, with the highest values observed in school-age boys. Total salt intake ranged from 5.46 to 7.43 g/capita/day, while fat intake reached 49.0–65.1 g/capita/day. One of the main food sources that contribute to salt and fat intake is street food and fast-food restaurants [44].

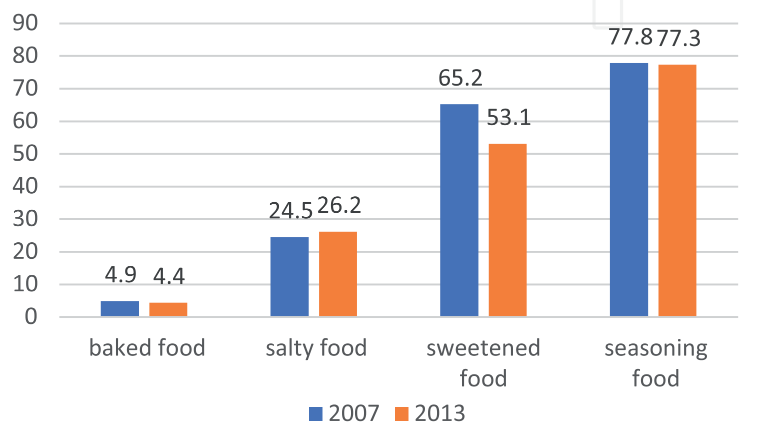

Figure 2.
The percentage of population aged 10 years and older to consume unhealthy food ≥1 per day in Indonesia in 2007 and 2013.

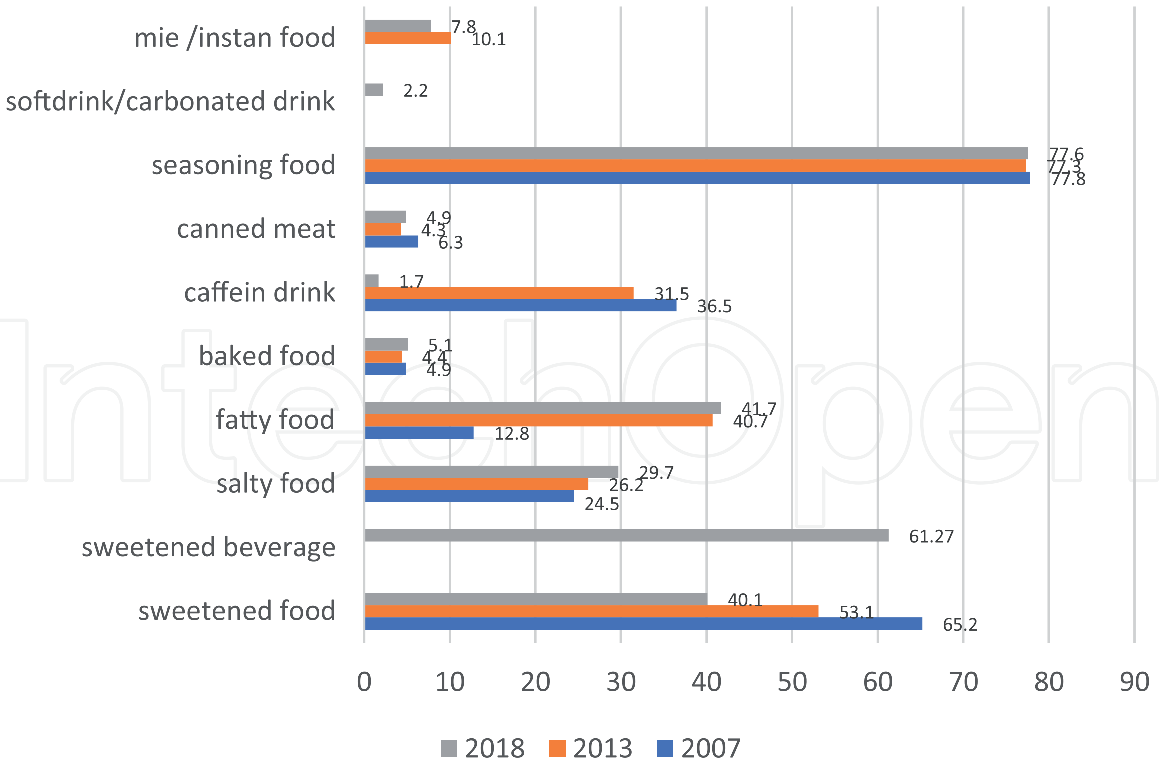

Figure 3.
Unhealthy food consumption based on Basic Health Research (RISKESDAS) 2007, 2013, and 2018.

3. Data and analysis

The population involved is those who suffered from infarct stroke and were treated at RSUD Dr. Soetomo. The population source was hospital-based because, to obtain data on stroke incidence, it must be based on a doctor's diagnosis, not based on the results of interviews. Case samples were infarct stroke incidences, which were taken by consecutive sampling from the case population with several inclusion criteria, including (1) aged 40 years and above, (2) male and female, (3) normal consciousness (GCS 4 5 6), and (4) willing to participate in the research (proven by informed consent). Meanwhile, the exclusion criteria were (1) having family comorbidity of stroke, (2) previous heart disease (proven by being hospitalized with a diagnosis of heart disease), and (3) aphasia. Furthermore, the sampling was carried out in the Neurology Inpatient Ward of RSUD Dr. Soetomo in Surabaya, Indonesia.

Based on the calculation, there were 79 samples obtained from each group. In this research, there were 82 samples for each group; thus, there were 164 samples involved. Data collection was carried out through several stages. The first stage is conducting direct examination of research subjects to obtain a diagnosis of infarct stroke (based on clinical signs, symptoms, and CT scan images) when the respondent arrived at the hospital. Second stage is examining the blood sugar, by collecting venous blood through taking 3 μl of serum added by 200 μl of reagent 1 and 200 μl of reagent 2, then incubated for 10 minutes, and read at wavelengths of 600 and 505 nm. The examination method used is the enzymatic method, which is the hexokinase method. This method was chosen because it has good precision and accuracy and is a referential method [45]. Casual blood sugar and HBA_{1C} examinations were carried out no later than 24 h after the respondents entered the nervous room [46]. After that, the respondents were required to fast for at least 10 h to check the fasting blood sugar in the next day. Then, respondents were asked to eat rice (the menu provided by the hospital) and 2 h after eating, and their blood was taken for blood sugar examination 2-h postprandial for cases. During the controls, casual blood sugar and HBA_{1C} tests were carried out before the interview, and then, respondents were asked to fast for at least 10 h before having their blood drawn the next day for fasting blood sugar checks. After the blood was taken, respondents were asked to eat rice, side dishes, and drink sweet tea equivalent to 600 to 650 calories. The respondents' blood was then taken again 2 h after eating for blood sugar examination 2-h postprandial. The examination results were categorized according to the *American Diabetes Association* (ADA) criteria and percentiles based on the average of these examination results.

This research employed a research instrument in the form of a questionnaire to obtain data on age, gender, blood sugar, medical history, which is diabetes mellitus. A computerized (CT) scan of the head was further conducted as the gold standard to determine the diagnosis of infarct stroke and to check serum sugar and cholesterol levels using the Hitachi 912 autoanalyzer.

4. Results and discussion

4.1 Results

4.1.1 Casual blood glucose according to infarct stroke status

The results showed that the average casual blood glucose (CBG) was 148.57 mg/dl with the lowest CBG level was 66 mg/dl and the highest CBG was 535 mg/dl. Based on the Kolmogorov–Smirnov normality test, p-value obtained was 0.000 indicating that the distribution of CBG data did not show a normal distribution. Therefore, CBG was classified according to the percentile method as follows:

Group I: CBG < 87 mg/dl

Group II: CBG 87 to 224 mg/dl

Group III: CBG > 224 mg/dl

The mean value of CBG in the infarct stroke was 186 mg/dl with a standard deviation of 14 mg/dl. Meanwhile, the mean value of CBG in the non-stroke group was 111 mg/dl with a standard deviation of 65 mg/dl.

This casual blood glucose (CBG) was categorized based on the *American Diabetes Association* (ADA) 2010 criteria [46]. The percentile method is shown in **Table 1**. Based on **Table 1**, there were only 4.9% of respondents who had CBG of 87 mg/dl in the infarct stroke group. Meanwhile, in the non-stroke group, almost 30% of respondents had CBG of 87 mg/dl. Furthermore, according to the criteria of percentile method, there were 28% of respondents who had CBG 224 mg/dl in the infarct stroke group and 4.9% of respondents with CBG 224 mg/dl in the non-stroke group. Furthermore, according to the ADA criteria, almost 50% of infarct stroke incidence had CBG levels of 140 mg/dl and above. On the other hand, 90.3% of non-stroke incidences had CBG level of less than 140 mg/dl..

4.1.2 Fasting blood glucose based on infarct stroke status

Fasting blood glucose (FBG) was categorized based on *American Diabetes Association* (ADA) 2010 criteria and percentile method as presented in **Table 2**. The fasting blood glucose (FBG) variable had an average fasting blood glucose level (FBG) of 114.07 mg/dl with the lowest fasting blood glucose level was 65 mm Hg, while the highest fasting blood glucose was 329 mg/dl. Based on the Kolmogorov–Smirnov normality test, the p-value obtained was 0.000, indicating that the

Disease	Casual blood glucose	Number	Percentage
Infarct stroke			
ADA criteria	<140 mg/dl	42	51.2
	140–199 mg/dl	13	15.9
	> = 200 mg/dl	27	32.9
Percentile method	<87 mg/dl	4	4.9
	87–224 mg/dl	55	67.1
	>224 mg/dl	23	28.0
Not stroke			
ADA criteria	<140 mg/dl	74	90.3
	140–199 mg/dl	2	2.4
	> = 200 mg/dl	6	7.3
Percentile method	<87 mg/dl	24	29.3
	87–224 mg/dl	54	65.9
	>224 mg/dl	4	4.9

Table 1.
Distribution of casual blood glucose (CBG) of the respondents based on the infarct stroke status according to the American Diabetes Association (ADA) 2010 criteria and percentile method.

Disease	Fasting blood glucose	Number	Percentage
Infarct stroke			
ADA criteria	<110 mg/dl	37	45.1
	110–125 mg/dl	12	14.6
	> = 126 mg/dl	33	40.2
Percentile method	<80 mg/dl	4	4.9
	80–159 mg/dl	54	65.9
	>159 mg/dl	24	29.3
Not stroke			
ADA criteria	<110 mg/dl	71	86.6
	110–125 mg/dl	5	6.1
	> = 126 mg/dl	6	7.3
Percentile method	<80 mg/dl	19	23.2
	80–159 mg/dl	61	74.4
	>159 mg/dl	2	2.4

Table 2.
Fasting blood glucose (FBG) of the respondents based on the infarct stroke status according to the American Diabetes Association (ADA) 2010 criteria and percentile method.

distribution of GDP data did not show a normal distribution. Therefore, FBG was classified according to the percentile method as follows:

Groups I: FBG < 80 mg/dl

Groups II: FBG 80 to 159 mg/dl

Groups III: FBG > 159 mg/dl

The average fasting blood glucose (FBG) in the infarct stroke group was 134 mg/dl with a standard deviation of 54 mg/dl, while in the non-stroke group it was 94 mg/dl with a standard deviation of 33 mg/dl.

According to ADA 2010 criteria, in the stroke-infarction group, there were 40.2% of respondents had a FBG level of 126 mg/dl or more, 14.6% of respondents had a FBG of 110 to 125 mg/dl, and 45.1% of respondents had a FBG 110 mg/dl. Meanwhile, in the non-stroke group, most respondents (86.6%) had a FBG of 110 mg/dl and only 7.3% of respondents had a FBG of 126 mg/dl or more. Furthermore, according to the percentile method, in terms of the infarct group, 29.3% of respondents had a FBG level of 159 mg/dl and only 4.9% of respondents had a FBG level of 80 mg/dl, while the remaining (65.9%) had a FBG level of 80 to 159 mg/dl. Meanwhile, in the non-stroke group, as many as 23.2% of respondents had a FBG of 80 mg/dl, only 2.4% had a FBG of more than 159 mg/dl, and 74.4% of the respondents had a FBG of 80 to 159 mg/dl.

4.1.3 Blood glucose of 2-h postprandial according to the infarct stroke status

The mean value of blood glucose of 2-h postprandial (BG2PP) was 144.32 mg/dl with the lowest blood glucose levels of 2-h postprandial was 68 mg/dl, while the highest was 483 mg/dl. Based on the Kolmogorov–Smirnov normality test, the p-value obtained was 0.000 indicating that the distribution of BG2PP data did not show a normal distribution. Therefore, BG2PP was classified according to the percentile method as follows:

Group I: BG2PP < 94 mg/dl

Group II: BG2PP 94 to 207 mg/dl

Group III: BG2PP > 207 mg/dl

The mean blood glucose of 2-h postprandial (BG2PP) in the infarct stroke group was 165 mg/dl with a standard deviation of 70 mg/dl, while in the non-stroke group was 124 mg/dl with a standard deviation of 62 mg/dl.

The blood glucose of 2-h postprandial (BG2PP) was categorized based on the American Diabetes Association (ADA) criteria 2010 and the percentile method as presented in **Table 3**.

According to the ADA criteria 2010, in terms of infarct stroke, there were 28% of respondents who had a BG2PP level of 200 mg/dl or more, 18.3% of respondents had a BG2PP level of 140 to 200 mg/dl, and 53.7% of respondents had a BG2PP level of 140 mg/dl. On the other hand, in terms of the non-stroke group, most of the respondents (84.1%) had a BG2PP level of 140 mg/dl and only 7.3% of respondents had a BG2PP level of 200 mg/dl or more. Meanwhile, according to the percentile method in the stroke-infarction group, there were 62.2% of respondents which

Disease	Blood glucose of 2 hours post-prandial	Number	Percentage
Infarct stroke			
ADA criteria	<140 mg/dl	44	53.7
	140–199 mg/dl	15	18.3
	> = 200 mg/dl	23	28.0
Percentile method	<94 mg/dl	11	13.4
	94–207 mg/dl	51	62.2
	>207 mg/dl	20	24.4
Not stroke			
ADA criteria	<140 mg/dl	69	84.1
	140–199 mg/dl	7	8.5
	> = 200 mg/dl	6	7.3
Percentile method	<94 mg/dl	21	25.6
	94–207 mg/dl	55	67.1
	>207 mg/dl	6	7.3

Table 3.
Blood glucose of 2 hours post-prandial (BG2PP) of the respondents based on the infarct stroke status according to the American Diabetes Association (ADA) 2010 criteria and percentile method.

had a BG2PP level of 94–207 mg/dl and 24.4% of respondents with BG2PP level of 207 mg/dl. Meanwhile, in the non-stroke group, there were 25.6% of respondents, which had a BG2PP level of 94 mg/dl, 67.1% of respondents had 94 to 207 mg/dl, and only 7.3% of respondents had a BG2PP level of more than 207 mg/dl.

4.1.4 Hemoglobin glycated (HBA_{1c}) according to the infarct stroke status

Variable of glycated hemoglobin (HBA_{1C}) level obtained the mean value of 6.37%. The lowest HBA_{1C} level was 3.5%, while the highest was 11.6%. Based on the Kolmogorov–Smirnov normality test, the p = value obtained was 0.011, indicating that the HBA_{1C} data distribution did not show a normal distribution. Therefore, HBA_{1C} was classified according to the percentile method as follows:

Group I: $HBA_{1C} < 6.1\%$

Group II: $HBA_{1C} \geq 6.1\%$

The mean value of HBA_{1C} level in the stroke infarct group was 7.07% with a standard deviation of 1.40%. Meanwhile, the mean value in the non-stroke group was 5.74% with a standard deviation of 0.97%. Furthermore, the HBA_{1C} levels were categorized according to the American Diabetes Association (ADA) criteria 2010 and the percentile method as described in **Table 4**.

According to the ADA criteria 2010, in the infarct stroke group, there were 67.1% of respondents who had HBA_{1C} level of 6% or more, while the remaining obtained HBA_{1C} level less than 6%. On the other hand, in the non-stroke group, most (64.6%) of the respondents obtained HBA_{1C} level of less than 6%, while 35.4% respondents had HBA_{1C} level of 6% or more.

According to the percentile method, in the infarct stroke group, there were 63.4% of respondents who had HBA_{1C} level of 6.1% or more, while the remaining 36.6% of respondents had HBA_{1C} level of less than 6.1%. On the other hand, in the non-stroke group, there were 67.1% of respondents who had HBA_{1C} level of less than 6.1%, while the remaining 32.9% of respondents had HBA_{1C} level of 6.1% or more.

4.2 Discussion

Based on the results that have been described above, it was discovered that the variable of blood glucose in the stroke infarct group was higher than the non-stroke group's. The mean value of casual blood glucose (CBG) in the infarct stroke group

Disease	HBA_{1C} level	Number	Percentage
Infarct stroke			
ADA criteria	< 6.0%	27	32.9
	> = 6.0%	55	67.1
Percentile method	< 6.1%	30	36.6
	> = 6.1%	52	63.4
Not Stroke			
ADA criteria	< 6.0%	53	64.6
	> = 6.0%	29	35.4
Percentile method	< 6.1%	55	67.1
	> = 6.1%	27	32.9

Table 4.
Hemoglobin glycated (HBA_{1C}) level of the respondents based on the infarct stroke status according to the American Diabetes Association (ADA) 2010 criteria and percentile method.

was 186 mg/dl, while the mean value of CBG in the non-stroke group was 111 mg/dl. Meanwhile, the fasting blood glucose (FBG) level in the infarct stroke group was 134 mg/dl, while in the non-stroke group it was 94 mg/dl. Furthermore, the blood sugar of 2-h postprandial (BG2PP) in the infarct stroke group was 165 mg/dl, while in the non-stroke group it was 124 mg/dl. These results supported the results of previous research conducted by Berger et al. [47] in which the FBG level in the stroke group was higher than in the non-stroke group, which was 106.1 mg/dl and 101.1 mg/dl, respectively.

Furthermore, another previous research project carried out by Boden-Albala et al. [48] revealed that the increase of FBG levels caused the risk of ischemic stroke also increased by 2.7 (95% CI: 2.0–3.8). In addition, it was reported that FBG level of 126 mg/dl to less than 150 mg/dl had a 5.1 (95%CI: 2.8–9.3) risk of ischemic stroke, while if the FBG level is 150 mg/dl, it had a risk of 3.3 (95%CI: 2.2–4.8).

Blood glucose level examination is an examination carried out to determine a definite diagnosis of diabetes mellitus. If the American Diabetes Association (ADA) 2010 criteria were used to determine the diagnosis of diabetes mellitus, the blood sugar level of 2-h post-prandial obtained that 28% of respondents have diabetes mellitus. This percentage figure is higher than the figure obtained from the research performed by O'Donnel et al. [49], in which 21% of ischemic stroke cases had diabetes mellitus. The results of this study are in accordance with previous studies that diabetes mellitus is a factor that increases the risk of ischemic stroke with a risk of 2.2 (95% CI: 1.9–2.6) [28] and a high risk of 1.78 (95% CI: 1.32–2.42) [50] while based on the gender, it was 2.27 (95% CI: 2.24–2.29) for men and 2.15 (95% CI: 2.13–2.17) for women [50, 51].

Other epidemiological studies have shown that diabetes is a risk factor for either ischemic stroke or infarct stroke or hemorrhagic stroke [30]. For example, findings from the Emerging Risk Factors Collaboration showed that the hazard ratio (HR) with diabetes was 2.27 (95% CI: 1.95–2.65) for ischemic stroke or infarct stroke, 1.56 (95% CI: 1.19–2.05) for hemorrhagic stroke, and 1.84 (95% CI: 1.59–2.13) for unclassified stroke [28, 52]. A cohort study was conducted in Taiwan, obtaining that the stroke incidence with and without diabetes was 10.1 and 4.5 per 1000 person-year, respectively. During the follow-up, diabetic patients had an increased risk of stroke (adjusted hazard ratio 1.75; 95%CI: 1.64–1.86) than those without diabetes. The relationship between diabetes and stroke risk was significant in both genders and all age groups [22].

In the glycated hemoglobin variable (HBA_{1C}), the average HBA_{1C} in the infarct stroke group was higher than the non-stroke group, which was 7.07 and 5.74%, respectively. Elevated glycated hemoglobin (HBA_{1C}) was an independent predictor of cardiovascular disease with a risk of 1.06 (95%CI: 1.02–1.11) [53]. In addition, the high HBA_{1C} level (>10.7%) was strongly related to stroke [47]. Diabetes is the most important risk factor for ischemic stroke either with diabetes mellitus alone or in combination between diabetes mellitus and hypertension [22, 29, 54]. Another study showed that the ischemic stroke group had significantly higher HBA_{1C} levels (5.9 ± 2.9% vs. 5.5 ± 1.6%) compared with the control group, while HBA_{1C} was a significant determinant of stroke ($p < 0.05$). HBA_{1C} was also significantly higher in the diabetic group compared with the non-diabetic (7.6 ± 2.1 vs. 6.1 ± 2.3) ($p < 0.05$) (7.6 ± 2.1 vs. 6.1 ± 2.3) ($p < 0.05$) [55].

In the current research, the blood glucose variable is a variable, which is strongly related to the incidence of infarct stroke because the highest consumption of carbohydrates in Indonesia is rice (1433 kcal/person/day), corn (228 kcal/person/day), and cassava (161 kcal/person/day) based on data from FAO. Based on the glycemic index, rice and corn have a high glycemic index (GI), which is more than 85 [56].

Variable	Validity		Reliability	
	coefficient	*p-value*	coefficient	*p-value*
Cigarette smoke exposure	0.16	0.05	0.97	0.00
History of hypertension	0.27	0.00	0.93	0.00
History of diabetes	0.73	0.00	0.46	0.00
History of hiperurisemia	0.17	0.00	0.97	0.00
Systolic blood pressure	0.50	0.00	0.75	0.00
Diastolic blood pressure	0.46	0.00	0.79	0.00
Casual blood glucose	0.93	0.00	0.13	0.00
Fasting blood glucose	0.97	0.00	0.05	0.00
Two hours post-prandial blood glucose	0.93	0.00	0.14	0.00
HBA_{1C}	0.70	0.00	0.52	0.00
Total cholesterol	0.20	0.02	0.96	0.00
HDL cholesterol	0.17	0.04	0.97	0.00

Table 5.
The coefficient of validity (λ), reliability (δ) and t-value of each variable compromising the infarct stroke risk index (IRSI) of type a on the final stage of confirmatory factor analysis.

This causes a large glucose load on the body causing a relative insulin deficiency. As a result, not all glucose can be converted into glycogen, resulting in excessive glucose in the blood, causing hyperglycemia.

Blood glucose level is a valid indicator of the risk of infarct stroke. This is proven when blood sugar variable consisting of casual blood sugar, fasting blood sugar, blood sugar of 2-h postprandial, and HBA_{1C} were analyzed together with the other variables (multivariable analysis). It was revealed that the four variables of blood sugar level showed the greatest validity coefficients based on confirmatory factor analysis, as shown in **Table 5**.

5. Conclusion

In Indonesia, it was revealed that stroke was the leading cause of death by 15.4% in 2007. A study conducted in the tertiary hospital revealed that 76% of stroke incidence in the last 10 years was ischemic stroke or infarct stroke. Another study showed that high prevalence of stroke was related to the increasing age, hypertension, and diabetes mellitus. The risk of stroke was 1.34 times higher in diabetes than those without diabetes.

In the current research, the blood glucose variable is a variable that is strongly related to the incidence of infarct stroke associated with the highest consumption of carbohydrates such as rice that is consumed three times a day in Indonesia, whereas it has a high glycemic index compared with other carbohydrate sources, as well, due to the lifestyle of the Indonesian people who like to eat sweet foods and drink sweet beverages. Therefore, education about food selection should be a priority in the effort to prevent infarct stroke and diabetes mellitus in Indonesia.

Efforts to prevent diabetes mellitus and infarct stroke should be considered since there is an emergence of COVID-19 disease, which has a worsening course and high fatality rate in people with comorbidities such as diabetes mellitus and stroke.

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Conflict of interest

The authors declare no conflict of interest.

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