

## Original Article

# Relationship between diet quality and fasting blood glucose levels in type II diabetes mellitus patients

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## Abstract

Maintaining good diet quality is important for controlling blood glucose levels in patients with type 2 diabetes mellitus (DM). At Cepiring Community Health Center in 2025, 93.6% of Chronic Disease Management Program (CDMP) participants had impaired fasting blood glucose. Poor diet quality may contribute to higher fasting blood glucose levels. This study aims to examine the relationship between diet quality and fasting blood glucose levels in type 2 DM patients who are part of the Chronic Disease Management Program (CDMP) at Cepiring Community Health Center. This cross-sectional study was conducted in February 2025 and involved 38 respondents. Diet quality was assessed using the Alternative Healthy Eating Index (AHEI) based on a 24-hour dietary recall. Fasting blood glucose data were obtained from medical records. Spearman and Pearson correlation tests were used to analyze the relationship between diet quality and fasting blood glucose. The results showed that most respondents were aged 60 years or older (55.3%), female (86.8%), unemployed (44.7%), and had low education levels (47.4%). Most had low physical activity (76.3%), no family history of DM (63.2%), and obese (42.1%). The highest AHEI component scores were found in alcohol, grains, sodium, red meat, sweetened beverages, PUFA, nuts, omega-3, trans fats, vegetables, and fruits. Bivariate analysis showed that low fruit scores ( $p=0.003$ ;  $r=-0.471$ ) and low total AHEI scores ( $p=0.004$ ;  $r=-0.453$ ) were associated with higher fasting blood glucose levels. Improving diet quality, especially increasing fruit intake, may help control fasting blood glucose in patients with type 2 DM.

**Keywords:** diabetes mellitus, blood glucose, diet quality

## Introduction

Diabetes Mellitus (DM) is one of the diseases marked metabolic with blood glucose in excess normal limits because of disturbance of insulin secretion or no optimal use of insulin in the body [1]. DM is divided into two types, namely type 1 DM and type 2 DM. According to PERKENI, type 2 DM is a condition characterized by resistance to insulin and decreased insulin production caused by the pancreas not being able to function optimally.

According to the International Diabetes Federation (IDF), Indonesia ranks 5<sup>th</sup> with 19.47 million DM patients and a prevalence of 10.6% [1]. The number of DM sufferers in Indonesia in 2021 reached 19.5 million and is estimated to increase to 21.3 million by 2030, resulting in 236,711 deaths, making it the 3<sup>rd</sup> leading cause of death with a percentage of 6.7% [2]. The prevalence of DM according to the Central Java Health Profile of Indonesia in 2023 was 9.59%. The number of DM sufferers in Kendal Regency in 2018 was 11,867 cases, which continues to increase annually to 19,681 cases in 2023.



According to data from the Kendal Regency Health Office, in 2021 there were 19,020 people with DM or 2.8% of the total population. population, so that DM becomes the main disease with no infectious disease in Kendal Regency. Based on the report on the implementation of CDMP at the Cepiring Community Health Center in January 2025, 93.6% of participants had impaired fasting blood glucose.

One cause of increased blood glucose levels is a poor diet. Research by Heryanda (2020) found that a decrease in diet quality can lead to an increase in fasting blood glucose levels of 12.1 mg/dL. Improving healthy eating habits by attention to diet quality can help stabilize blood glucose levels, thus preventing DM. complications disease others. Based on study previously, DM patients with good diet quality have a chance to have 3 times control optimal glycemic [3]. Diet quality is evaluation of food that can describe sufficiency and balance substance nutrition, diversity, security or quality food and control consumption substances that have an impact negatively, so that not only focus on one substance nutrition just [3, 4]. Someone not only consumes food with substance nutrition separated but food with combination substance complex nutrition in it and requires balanced intake substance nutrition [3].

One parameter for measuring diet quality is the Alternative Healthy Eating Index (AHEI). AHEI is used to measure the quality of diet and dietary compliance of the American public, adapted from the Dietary Guidelines for Americans (2018). AHEI is adapted to the portion of food components commonly consumed by Indonesians [5]. The AHEI-2010 that has been developed is stated to be valid for measuring and assessing diet quality and can provide dietary recommendations that better describe the intake of food and other nutrients related to chronic diseases, especially DM [6]. DM sufferers have perceived diet quality needs improvement (need improvement) because low consumption recommended foods and high consumption of foods that are not recommended. A carbohydrate-restricted diet alone is not enough for DM sufferers, but it is necessary to pay attention to the intake of other sources of nutrients including vegetables, fruits, grains, sweetened drinks, nuts, red meat, trans fats, omega-3, PUFA, sodium and alcohol [5].

The relationship between diet quality and metabolic parameters such as blood glucose levels has not been widely studied simultaneously, particularly in the Indonesian population of type 2 DM patients. This is important because the Indonesian diet has unique characteristics, such as high consumption of white rice

and low consumption of whole grains and vegetables. Therefore, this study sought to explore the relationship between diet quality, as measured by the Alternative Healthy Eating Index (AHEI), and blood glucose levels in Indonesian DM patients.

## Material and methods

### Study design and participants

This study is cross sectional study on type 2 DM patients at the Community Health Center Cepiring, Indonesia in 2025. This study has obtained ethical approval from the Health Research Ethics Committee of the Semarang Health Polytechnic under the Ministry of Health, No.361/EA/F.XXIII.38/2025. Population study is all over type 2 DM patients on CDMP Community Health Center Cepiring. Retrieval sample with method purposive sampling. The sample in study was 38 people without dropping out, with criteria inclusion: registered as a participant in the Cepiring Health CDMP, suffering from type 2 DM for at least 1 year, willing to participate in the research by signing an informed consent, having fasting blood glucose level test results, patients with  $\leq 2$  complications, able to communicate with well, no experience disturbance memory or must accompanied by family, already get education nutrition, no get insulin therapy.

### Laboratory and clinical data collection

Independent variables in this study were diet quality, which was assessed using a 24-hour dietary recall. The recall data were analyzed based on the 11 components of the Alternative Healthy Eating Index (AHEI)-2010, including vegetables, fruits, whole grains/staple foods, sugar-sweetened beverages, nuts, red meat, trans fats, omega-3 fatty acids, polyunsaturated fatty acids (PUFAs), sodium, and alcohol. The 24-hour recall was used to get the respondents' dietary intake during the 24 hours preceding data collection, reflecting their most recent eating behavior.

The AHEI instrument was originally designed by NHANES using a Food Frequency Question (FFQ). However, the AHEI instrument has also been continuously developed based on a 1x24-hour recall [7]. This is because the 24-hour recall is easier to use, especially for the elderly [8]. The choice of recall in this study is expected to make it easier for respondents to remember what they ate the day before compared to having to

remember food consumed over a long period. In addition, the recall is expected to be more representative in describing fasting blood glucose levels.

The dependent variable in this study was fasting blood glucose (FBG) level, which was obtained from laboratory test results using capillary blood samples collected from the respondents. The FBG data used in this study refer to the most recent measurement, conducted on the same day as the dietary intake data collection.

In addition, there are characteristics respondents (age, gender, address, education level, occupation, height, weight of respondents, physical activity, history of DM, compliance with medication consumption and nutritional status) who will serve in form presentation.

### Statistical analysis

The statistical analyses used in this study included the Spearman and Pearson correlation tests. The

Spearman correlation was applied to assess the relationship between each component score of the AHEI (non-normally distributed data) and fasting blood glucose levels. Meanwhile, the Pearson correlation was used to examine the relationship between the total AHEI score (normally distributed data) and fasting blood glucose levels.

### Results

Study this performed on CDMP Cepiring with a sample totaling 38. Characteristics respondents in the study consist of from age, gender, address, education level, occupation, height, weight of respondents, physical activity, history of DM, compliance with medication consumption and nutritional status.

Table 1 shows that the majority of respondents are aged  $\geq 60$  years (55.6%), of the same sex, women (86.8%), no graduated from elementary school/Islamic

Table 1: Characteristics respondents.

Characteristics	n	%
<b>Age</b>		
Mature young (25–44 years)	3	7.9
Mature old (45–59 years)	14	36.8
Elderly ( $\geq 60$ years)	21	55.3
<b>Gender</b>		
Man	5	13.2
Woman	33	86.8
<b>Educational attainment</b>		
No formal education or did not complete primary education	18	47.4
Completed primary education	13	34.2
Completed lower secondary education (junior high school)	2	5.3
Completed upper secondary education (senior high school)	4	10.5
Completed post-secondary non-tertiary education or tertiary education (diploma or bachelor's degree)	1	2.6
<b>Occupational status</b>		
Unemployed	17	44.7
Civil servant	1	2.6
Self-employed	4	10.5
Farmers, fishermen, or laborers	3	7.9
Private-sector employee	3	7.9
Other	10	26.3

Table 1: Continued.

Characteristics	n	%
<b>Activity physique</b>		
Light (1.40–1.69)	29	76.3
Medium (1.70–1.99)	9	23.7
Heavy (2.00–2.40)	0	0
<b>DM history</b>		
N't any family history of DM	24	63.2
There is a family history of DM	14	36.8
<b>Compliance with medication consumption</b>		
Obedient	21	55.3
Not obey	17	44.7
<b>Nutritional status</b>		
Underweight (<18.5 kg/m <sup>2</sup> )	2	5.3
Normal (18.5–22.9 kg/m <sup>2</sup> )	14	36.8
Overweight (23–24.9 kg/m <sup>2</sup> )	6	15.8
Obesity (≥25 kg/m <sup>2</sup> )	16	42.1
<b>FBG level</b>		
Normal (70–99 mg/dL)	7	18.4
Impaired (≥100 mg/dL)	31	81.6

elementary school (47.4%), no work (44.7%), activities physique light (76.3%), no There is family history of DM (63.2%), adherent consumption medication (55.3%) and nutritional status obesity (42.1%).

Table 2 shows level blood glucose fast respondents with average 121.84 mg/dL.

Diet quality is evaluation of intake or pattern rated food based on certain guidelines. Research this using AHEI as an instrument for evaluating Diet quality in type 2 DM patients. Analysis bivariate in research this can be seen in Table 3.

Table 3 shows component related diet quality with level blood glucose fast DM patients on CDMP Cepiring is component fruits (p=0.003) (r=-0.471) and total score (p=0.004) (r=-0.453). Components of other diet qualities in the form of vegetables, grains, drinks sweet-

ened, nuts, meat red, trans fat, omega-3, PUFA, sodium and alcohol do not relate with level blood glucose fast.

## Discussion

### Characteristics respondents

The majority of respondents is elderly (age >60 years) and amounted to 55.3% (21 respondents). Type 2 DM is often found at the age of elderly that is 85–90% of total DM sufferers and the highest incidence found in residents aged ≥60 years [9]. According to results of the Indonesian Health Survey 2023, prevalence DM sufferers aged 55–64 were 6.6% and those aged 65–74 were 6.7%. This is caused by changes in the component body

Table 2: Respondents fasting blood glucose levels.

	Mean	SD	Min	Max
<b>FBG level (mg/dL)</b>	121.84	23.79	86	193

Table 3: Relationship diet quality with respondents FBG levels.

Component	r	p-value
Vegetables	-0.014	0.935
Fruits	-0.471	0.003*
Grains	-0.263	0.111
Drink sweetened	-0.313	0.056
Nuts	-0.251	0.128
Meat red	-0.208	0.209
Trans fats	0.119	0.476
Omega-3	-0.024	0.885
PUFA	-0.076	0.649
Sodium	0.068	0.687
Alcohol	-	-
Total score	-0.453	0.004**

Note: \* –  $p < 0.05$  indicates significant relationship (Spearman); \*\* –  $p < 0.05$  indicates relationship significant (Pearson).

that results in damage to cells and tissues at age elderly so that control level blood glucose is not optimal [10].

The majority of respondents were female for 86.8% (33 respondents). According to Indonesian Health Survey (2023), the prevalence of diabetes mellitus (DM) is higher in women (2.7%) compared to men (1.8%). Similar findings were reported by Akhsyari [11], who stated that the proportion of DM tends to be higher among women. This may be attributed to hormonal factors that influence the severity of DM. Women experience hormonal fluctuations due to the menstrual cycle and menopause. A decline in estrogen and progesterone levels can promote fat accumulation and contribute to insulin resistance [12].

Majority respondents study no formal education or did not complete primary education amounted to 47.4% (18 respondents). According to Mayasari (2020) DM incidents can influenced by the level education, where people who have higher education tend own management, how to think and act can influence on wareness of each respondent. In line with study Gharaibeh (2018) who said that knowledge possessed DM sufferers are means for handling his illness, lack of knowledge about DM will result in reduced effectiveness in handle condition DM sufferers.

Majority respondents study no work by 44.7% (17 respondents). In line with study previously said that type work is also related with DM, work will influence level activity physically, where no existence activity work tends to cause lack of physical exercise and activ-

ity physique classified as light [13]. Activities sufficient physically can control level blood glucose [14].

Majority respondent's own activity physique with category light by 76.3% (29 respondents). The lack of activity physique is one of the factors worsening DM disease. Activity physique relates directly with stability amount glucose in blood. During exercise, glucose in muscle will utilize the body and if experienced emptiness so muscle will take glucose in blood. This will cause blood glucose to go down and improve control of blood glucose [13].

Most of the respondents no have a family history of DM by 63.2% (24 respondents). The history of DM from parents is one of the causes of DM. De Zoysa's research (2024) shows that patients who have parents DM sufferers at the age of young, have control good and better glycemic adherence to the recommended diet compared to with DM sufferers who do not own history family. Because behavior management good self-started from awareness will history disease family [15].

Most of the respondents obedient by 55.3% (21 respondents). According to Bulu *et al.* (2019), patients who routinely or obediently consume drug more capable guard level blood glucose remains normal compared to patients who do not consume drug [16]. The medication given Community Health Center Cepiring to participant CDMP namely metformin and glibenclamide. Both of them are anti-hyperglycemic drugs. How metformin works (class biguanid) namely with lower concentration level blood glucose however no

will cause hypoglycemia, whereas method work glibenclamide (group sulfonylureas) namely stimulate insulin secretion so that it happens to decline level blood glucose [17].

Most of the respondents classified as obese with a BMI  $\geq 25$  kg/m<sup>2</sup> of 42.1% (16 respondents). According to Hasanah, high BMI is related with height level blood glucose [18]. In patients with nutritional status more will experience excess energy that will be saved in fat form, thing this will cause insulin resistance and make blood glucose uncontrolled [19].

Majority respondents own level blood glucose Interrupted fasting ( $\geq 100$  mg/dL). Glucose levels blood fasting (FBG) is an indicator important for monitoring control glycemic DM patients. Based on study previously, the level of blood glucose high fasting can be caused by several factors like irregularity monitoring intake of food, low knowledge about safe diet as well as limitations in the economy [20].

### Respondents fasting blood glucose levels

Majority respondents Still own level blood glucose above normal (70–99 mg/dL), namely 121.84 mg/dL. DM sufferers are recommended for guard level blood glucose approaching normal as control glycemic for lower risk complications disease other [21].

### Relation diet quality with fasting blood glucose levels

There is a relationship between component fruits with level blood glucose fasting. Direction of relationship nature negative ( $r = -0.471$ ) which means the higher score fruits (more and more) good pattern consumption) then level blood glucose fast tends to be low. This shows the important role of consuming fruits in controlling glycemia. In line with previous study which shows that respondents who consume fruits own 3.48 times more likely to reach control optimal glycemia [22]. Rich in fruits, antioxidants, fiber, vitamins and beta-carotene which are able to increase insulin sensitivity due to own effect protective to pancreatic beta cells [23]. This is strengthened with the results study previously said that increasing factor risk hyperglycemia can cause by lack of consumption of fruits per day [24]. Consumption fruit daily respondents' study This is bananas (1–2 portions/day), papaya (1 portion/day) and oranges (1 portion/day) which are fruits with fructose content low until moderate and classified as index glycemic low. Research Ruiza (2018) explains that consumption of fructose tall can cause insulin resist-

ance and contributes to the incidence of type 2 DM [25]. In addition, consumption of fruits with index glycemic low can be beneficial for increasing the function of pancreatic beta cells in producing good insulin for DM diet management [26]. Consumption of fruit daily in Indonesia which is still classified as low, whereas study this only evaluates intake eaten in one day, which may not yet represent intake fruit daily in a way consistent, then from that matter this be one of limitations in this study.

In statistics, there is no significant relationship between component vegetables with level blood glucose fasting in type 2 DM patients ( $p = 0.935$ ). Although thus, the value correlation shows the relationship is very negative weak ( $r = -0.014$ ) which indicates that consumption of more vegetables low tends followed with level blood glucose high fasting. This result is in line with study Munyogwa and Maregesi (2024), who stated that consumption of vegetables does not relate in a way significant with glycemic control in DM patients. Research explains that although vegetables can support glycemic control, its effects very depending on the type and amount consumed. Not all type vegetables have as big as consuming fruits. Therefore, permanent DM sufferers recommended consuming vegetables  $\geq 1/2$  a plate every day as part from a balanced diet [27].

There is no relationship between component grains with level blood glucose fasting in type 2 DM patients statistics ( $p = 0.111$ ). However, the direction correlation with negative value shown ( $r = -0.263$ ) indicates that consumption of more grains tend to follow glucose level more blood low. Grains are source energy, the main thing that remains required for DM sufferers for fulfil need [28]. Every day respondents consume white rice which is food with index high glycemic [29]. Meanwhile election material food with index low glycemic is one of the arrangements to help control blood glucose [30]. This is caused by material food with index glycemic low No cause surge improvement blood glucose in a way fast [31].

There is no significant relationship between component drinks sweetened with level blood glucose fasting ( $p = 0.056$ ) and showed correlation negative ( $r = -0.313$ ). This means that the lower consumption drink sweetened precisely tends followed by an increased glucose level fasting. This is not in accordance with study previously, which stated that consumption of drink sweeteners, especially those high in added sugar like sucrose or fructose, contributes to improvement in blood glucose and insulin resistance. Respondents with high blood glucose fasting possibly tend to

reduce consumption, drink sweetened or report more consumption low because awareness will condition health. In addition, other dietary components, such as intake fiber, total energy or index glycemic other foods can also influence blood glucose level fast [32].

Component nuts also do not show significant relationship in a way statistic ( $p=0.128$ ), although direction relationship negative ( $r=-0.251$ ) indicates that consumption of high – calorie nuts can lower level blood glucose. Nuts contain fiber that can help control glyce-mic. Based on results from the study Susilowati (2020), consumption of nuts (natural) and processed) in large numbers was found in the type 2 DM group not controlled by 40.6–62.5% while the group controlled only by 0–33.3%. In the study the explained that nuts can be made into good food because their own low glyce-mic index is good for DM patients, however need to be noticed again level fulfillment energy, carbohydrates, protein, fat and fiber as well as quality from materi-al food that alone [33]. According to PERKENI (2021), the recommended amount of fiber for DM sufferers is 20–35 gr/day, whereas consumption nuts respondents' study has not yet fulfilled recommendation.

There is no relationship between component meat red with level blood glucose fasting in type 2 DM pa-tients statistics ( $p=0.209$ ) and has direct relationship negative between score meat red with level blood glu-cose fasting ( $r=-0.208$ ). This means that high consump-tion of red meat tend followed by glucose levels more blood low. This is departed from studies that show that consumption of red meat, especially meat processed foods containing salt, nitrite etc. more increase risk disturbance metabolic such as type 2 DM [34]. This is caused by several factors that affect possible negatives that arise from consumption of red meat very low in this sample study (average 0.1 servings/day). If the diet is generally considered bad, red meat can become a source of protein that helps control simple carbohy-drate intake so that it looks correlated negatively to lev-el blood glucose, with limit consumption >50 grams/day [35]. In addition, the method 1x24 hour recall can create bias especially for some people who don't con-sume red meat every day. Consume <50 grams of meat red per day No show effect significant negative to level blood glucose [36].

Not found relationship significant between con-sumption of trans fats with level blood glucose fasting in ( $p=0.476$ ;  $r=0.119$ ). The direction of correlation posi-tively shows that high trans-fat intake tends followed with improvement level blood glucose. Trans fats are results from frying with a temperature of 180–220°C

or through a hydrogenation process. Consumption of these trans fats allegedly as reason for occurrence dis-ease heart coronary heart disease and DM [37]. Trans fats can increase total cholesterol and LDL which can increase risk of disease cardiovascular in DM pa-tients [36, 38].

In a way statistic there is no relationship between omega-3 components with level blood glucose fasting in type 2 DM patients ( $p=0.885$ ) and have direction re-lationship negative ( $r=-0.024$ ) indicates that low ome-ga-3 consumption tends followed with glucose level more blood high. In line with Putri's research (2021) which says that no found difference level blood glucose between before and after giving omega-3 supplementa-tion. In fact, improvement in glucose level postprandi-al blood that is not significant after respondents con-sume omega-3 supplements, things This caused by the dose low supplementation (240 mg EPA and DHA) and control to daily diet No done [39].

In a way statistic no there is relationship between PUFA components with level blood glucose fasting in type 2 DM patients ( $p=0.649$ ) and have direction re-lationship negative ( $r=-0.076$ ) which indicates that high PUFA consumption tend followed with glucose level low blood pressure. Brown 's research (2019) shows that total polyunsaturated fatty acids, omega-3 and omega-6 have little influence even though the same very few there is influence for treatment of type 2 DM [40]. Most of the studies use dose low until dose moderate PUFA but no there is benefit real on metabolism of blood glu-cose, even study with dose high (>4.4 grams/day) also has effect negative like blood glucose fast increased and occurred insulin resistance [40].

There is no relationship between sodium com-ponent and level blood glucose fasting in type 2 DM patients. Although not significant in a way statistic ( $p=0.687$ ) but relationship positive between sodium and level blood glucose fasting ( $r=0.068$ ) show that high sodium consumption tends to be followed with glucose level more blood high too. Habits consuming high so-dium can cause pressure blood increase if accompa-nied by activity sufficient physical condition. This is caused by the nature of sodium which binds water will cause blood volume to increase which means the more pressure increases in blood [41]. Meanwhile high blood pressure is beginning to occur DM complications [42]. Based on Bertalina's research (2017) which states that sodium intake is related to blood pressure in patients with coronary heart disease [42].

Component alcohol can't be analyzed in this study because all respondents report no consumption of

alcohol, so is data variation where all respondents have a score maximum that is 10 scores.

There is relationship significant between total AHEI score with level blood glucose fasting ( $p=0.004$ ;  $r=-0.453$ ) which shows that the more good diet quality, then level blood glucose fast tend more low. In line with Antonio's research (2019) which says low diet quality is related with the bad control glycemic in type 2 DM patients, on the other hand height diet quality is related with the good control glycemic [3]. Based on Pushpita De's research (2018), patients who did not follow diabetes self-care management characterized by compliance with low to diet quality can result in poor glycemic control [43]. Election material food with fructose and index glycemic low can help stabilize level blood glucose fasting. Because of this that although there is relationship in a way significant between score diet quality with level blood glucose fasting, DM patients remain must repair quality his diet based on recommendations that have been set.

Like case in point research in general, study this still has a number of necessary limitations noticed and become considered researchers next. The AHEI instrument used has not yet determined a clear cut-off point for giving score consumption outside criteria score maximum or minimum such as trans-fat  $\leq 0.5\%$  energy, PUFA  $\leq 2\%$  energy and alcohol  $\leq 0.5$  servings. small sample as well as not using the level parameter glucose 2-hour postprandial blood or HBA1C greater than stable to evaluate control glycemic term long. Besides that, no known whether respondents experience insulin resistance or disturbance insulin secretion as well as no existence information for analyzing type medication and dosage consumed respondents, who are afraid to become the most dominant influence to level blood glucose fasting. Recall 1x24 hours as instrument intake is very memory dependent, especially for respondents the elderly dominates studies of this and potentially cause underreporting or overreporting. This is needed for accuracy for dig information and has minimized through existence apperception with enumerators and existence attachment material food based on AHEI components.

## Conclusion

Improving diet quality, particularly through fruit consumption, plays an important role in controlling fasting blood glucose levels in patients with type 2 diabetes mellitus. Better fruit consumption is associated

with lower fasting blood glucose levels, supported by the fiber, antioxidants, vitamins, and beta-carotene content in fruits that can increase insulin sensitivity and protect pancreatic beta cell function. Therefore, fruit consumption, especially fruits with a low glycemic index, should be part of a dietary management strategy to help achieve optimal glycemic control in patients with type 2 diabetes mellitus.

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## Conflict of interest

The authors declare no conflict of interest.

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