



## Relationship Between HbA1c Value and Duration of Diagnosed Type 2 Diabetes Mellitus with the Incidence of Fatty Liver Disease at Waled Cirebon Regional General Hospital

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KEYWORDS	ABSTRACT
HbA1c; duration of type 2 diabetes mellitus diagnosis; fatty liver disease	Fatty liver disease is the accumulation of fatty acids in the form of triglycerides in the cytoplasm of hepatocytes. Patients with type 2 diabetes mellitus have a risk approximately 3-5 times greater of developing fatty liver disease. Decreased glucose utilization by body cells caused by type 2 diabetes mellitus causes an increase in fat metabolism, which causes the liver to accumulate fat, leading to fatty liver disease. To determine the relationship between HbA1c values and the duration of type 2 diabetes mellitus diagnosis with the incidence of fatty liver disease at Waled Regional General Hospital, Cirebon, this study used an observational analytical method with a cross-sectional design. Data were obtained from interviews and medical records. 33 patients who met the inclusion criteria was obtained using the total sampling technique. The analysis test in this study used Fisher's Exact Test. Most patients had poor HbA1c control (57.6%) and the duration of type 2 diabetes mellitus diagnosis with a range of <5 years (54.5%), and as many as 69.7% of patients did not experience fatty liver disease. The bivariate analysis showed a p-value of 0.707 for HbA1c values and fatty liver disease incidence and a p-value of 0.020 for duration of type 2 diabetes mellitus diagnosis (PR=4.800; 95% CI=1.196-19.266). This study did not find a relationship between HbA1c values and fatty liver disease incidence, but a significant association was found between the duration of type 2 diabetes mellitus diagnosis and fatty liver disease incidence at Waled Regional General Hospital, Cirebon.

### INTRODUCTION

Fatty liver disease is defined as the accumulation of fatty acids in the form of triglycerides within the cytoplasm of hepatocytes. (Setiati et al., 2014) Fatty liver disease can be divided into two groups, namely Non-Alcoholic Fatty Liver Disease (NAFLD) and Alcoholic Liver Disease (ALD). (Topal et al., 2021) Non-Alcoholic Fatty Liver Disease (NAFLD) is a liver disorder caused by the accumulation of fat, especially triglycerides, in hepatocytes, exceeding 5% of all hepatocytes, with macrovesicular or microvesicular involvement, fibrosis, and even cirrhosis, without a history of significant alcohol consumption. (Sriwaningsi et al., 2023) Meanwhile, Alcoholic Liver Disease (ALD) is a liver disease caused

by excessive alcohol consumption. Fatty liver disease can cause liver inflammation, known as steatohepatitis. If the inflammation persists and is not properly treated, this condition can lead to the development of liver fibrosis, cirrhosis, and even liver cancer (Firmansyah et al., 2024).

Fatty liver disease is a significant global health problem, with a worldwide prevalence in adults of approximately 25%, increasing in recent years to over 30%. In Asia, the prevalence is particularly high, reaching 30.8%. In Southeast Asia, the prevalence of this disease has also increased by around 42%, partly driven by the rising number of cases of type 2 diabetes mellitus. In Indonesia, it has been recorded that around 51.04% of the population is affected by fatty liver disease (Teng et al., 2023).

In some regions of the world, fatty liver disease is projected to increase significantly by 2030 if its incidence is not controlled. Several population-based studies have reported that the prevalence of fatty liver disease is higher among patients with type 2 diabetes mellitus, ranging from 30% to 70%, and a recent meta-analysis shows that the overall prevalence of this disease is approximately 55.5% among these patients. Patients with type 2 diabetes mellitus have a mortality risk from fatty liver disease that is approximately 3–5 times greater than that of individuals without type 2 diabetes mellitus (Huh et al., 2022).

Diabetes Mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia resulting from abnormalities in insulin secretion, insulin action, or both. The World Health Organization (WHO) reported that the death rate due to DM increased by 3% from 2000 to 2019, with DM being the direct cause of death for 1.5 million people in 2019. The number of individuals with DM is estimated to increase from 171 million in 2000 to 300 million in 2025 and 366 million in 2030. (Balooch Hasankhani et al., 2023) The International Diabetes Federation (IDF) estimates that the number of people with diabetes in Southeast Asia will increase by 68%, reaching 152 million by 2045. (Federation, 2021) The WHO also estimates an increase in the number of individuals with type 2 DM in Indonesia from 8.4 million in 2000 to approximately 21.3 million in 2030. The IDF reports that from 2013 to 2017, the number of individuals with DM is projected to rise from 10.3 million to 16.7 million by 2045. (Indonesia, 2020) Based on the Indonesian Health Survey (SKI), the prevalence of DM diagnosed by physicians across all age groups in West Java Province is approximately 156,000 individuals. (Health & BKPK, 2023) Meanwhile, according to the 2018 Riskesdas, the prevalence of DM in Cirebon Regency was 0.87%, or approximately 3,281 patients (Indonesia, 2019).

Type 2 diabetes mellitus (type 2 DM) is one of the risk factors associated with fatty liver disease (Maulana & Kuswarini, 2022). Decreased glucose utilization by body cells due to type 2 diabetes leads to increased fat metabolism. Abnormalities in fat metabolism increase the liver's workload. Enhanced lipogenesis and lipolysis caused by type 2 diabetes result in fat accumulation in the liver, leading to fatty liver disease (Masroor & Haque, 2021).

The urgency of this research is underscored by the high and increasing prevalence of both type 2 DM and fatty liver disease in Indonesia, particularly in West Java and Cirebon Regency. Without a clear understanding of local contributing factors to fatty liver disease among diabetic patients, effective preventive and screening interventions cannot be properly targeted. The novelty of this study lies in its specific focus on the Waled Cirebon Regional General Hospital population, a setting with unique demographic and healthcare access characteristics that have not been previously studied in relation to this topic. This research

provides contemporary, localized data that can inform clinical practice and health policy in this region.

Based on the background presented above, the research question in this study is whether there is a relationship between HbA1c values and the duration of diagnosis of type 2 diabetes mellitus with the incidence of fatty liver disease at Waled Cirebon Regional General Hospital.

## **METHOD**

Data collection in this study was carried out at the Waled Regional General Hospital, Cirebon in April - June 2025.

Based on the problems being researched, the method used is analytical observational research using a cross-sectional approach sectional, to determine the relationship between HbA1c values and the duration of diabetes diagnosis mellitus type 2 with the occurrence of fatty liver disease. Data collection conducted at one time through interviews and medical records.

The target population of this study is all type 2 DM sufferers. 2 in Cirebon. The accessible population of this study was all type 2 DM patients who came for examination at the Internal Medicine Polyclinic of Waled Cirebon Regional Hospital during the period April-June 2025.

### **1. Research Sample**

#### **a. Inclusion Criteria**

- 1) Type 2 DM patients undergoing examination at Waled Regional General Hospital, Cirebon.
- 2) Type 2 DM patients aged 18-70 years.
- 3) Medical record data is supplemented with HbA1c values for at least the last 6 months and includes liver ultrasound data.
- 4) Patients who were willing to participate in an interview were asked about the duration of their type 2 DM diagnosis.
- 5) Patients who agreed to participate in this study.

#### **b. Exclusion Criteria**

- 1) Patients with a history of alcohol consumption.
- 2) Patients who do not agree to participate in this study.
- 3) Patients with incomplete medical record data.

### **2. Sampling Method**

The sampling technique used in this study was total sampling, where all members of the population were used as samples.

### **3. Sample Size**

The sample size was not calculated because this study used a total sampling technique. All patients with type 2 diabetes mellitus recorded in medical records at Waled Regional General Hospital, Cirebon, were included in the sample.

### **4. Variables Study**

#### **a. Independent Variable**

The independent variables in this study were HbA1c values and the duration of diagnosis of type 2 diabetes mellitus.

#### **b. Dependent Variable**

The dependent variable in this study is the incidence of fatty liver disease.

## 5. Definition Operational

**Table 1 Operational Definitions**

Variables	Operational Definition	Measuring instrument	Measurement Results	Scale
HbA1c	The HbA1c value produces a glycemic index in patients as a measuring value for the development of Diabetes Mellitus which is measured through laboratory examination and recorded in medical records.	Medical records	Bad $\geq 7$ Good $<7^{(35)}$	Ordinal
Duration of diagnosis of type 2 diabetes mellitus	The time period between the patient being diagnosed with diabetes mellitus until the time the study was conducted.	Interview	$\geq 5$ years $<5$ years <sup>(35)</sup>	Ordinal
<i>Fatty liver disease</i>	This condition is characterized by an increase in fat levels in the liver in the form of triglycerides exceeding 5% of liver weight, and can be proven by an ultrasound examination (USG).	Medical records based on ultrasound results	Yes No	Nominal

## Data Collection Method

### 1. Tools and materials

Data collection on HbA1c values was conducted using secondary data taken from patient medical records, and the duration of type 2 diabetes diagnosis was conducted through interviews with patients. Data on fatty liver disease were collected using medical records based on ultrasound results performed at Waled Regional General Hospital, Cirebon.

### 2. Research Procedures

The research procedure was carried out in 3 stages, namely:

#### a. Preparation Stage

- 1) Determine and establish the research title
- 2) Consultation with the supervising lecturer regarding the title, research variables and research methods
- 3) Taking care of ethical clearance
- 4) Prepare permits and coordinate with the heads of relevant agencies
- 5) Set a schedule of activities.

#### b. Implementation stage

- 1) Explain the goals and benefits to the hospital

- 2) Ask permission from the hospital and the medical records department
- 3) Determining samples according to inclusion criteria
- c. Completion stage
  - 1) Managing data and analyzing data
  - 2) Compiling research reports.

### Research Flow

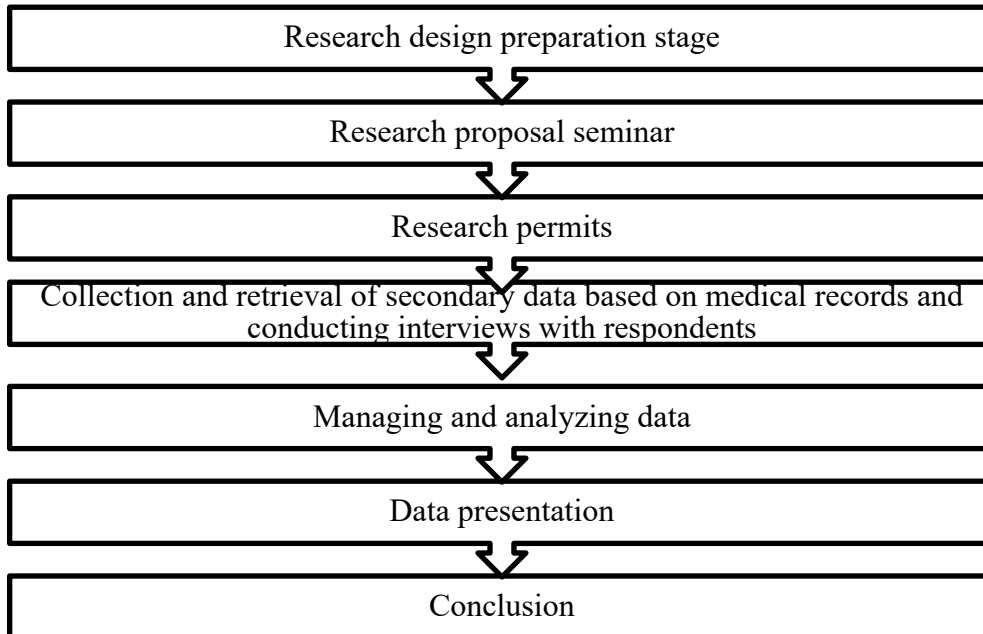


Figure 1 Research Flow

### Management and Data Analysis

#### 1. Data management

Data processing includes the following processes:

- a. Editing to check the completeness of the data
- b. Coding to score each item, by changing the level of agreement into a quantitative value.
- c. Data entry, entering data to be processed using a computer program for analysis.
- d. Tabulating, the activity of entering data in tabular form.

#### 2. Data analysis

##### Univariate Analysis

Analysis univariate aim For explain characteristics every variables research. Analysis univariate done For explain distribution frequency from each variable studied includes HbA1c and duration diagnosed with diabetes mellitus type 2 and incident fatty liver disease.

#### 3. Bivariate Analysis

Analysis bivariate is analysis conducted on two variables . Analysis bivariate aim For know connection variables independent that is HbA1c value and duration diagnosed with diabetes mellitus type 2 with variables dependent that is incident fatty liver disease . In study This analysis bivariate done with Fisher's exact test .

## Research Ethics

This research has received approval from the Health Research Ethics Committee (KEPK) of Waled Regional Hospital with a permit letter or ethical clearance number of 000.9.2/145/KEPK/II/2025 and has fulfilled the administrative requirements of Waled Regional Hospital Cirebon, namely a research permit from the Faculty of Medicine UGJ and a research certificate from the National Unity and Politics Agency (KESBANGPOL).

## RESULT AND DISCUSSION

The study was carried out at the Polyclinic Internal Medicine Department in Waled Regional General Hospital from April–June 2025 using a total sampling technique. The researchers obtained a study sample of 102 patients who agreed to informed consent and were willing to participate in interviews. Patients who met the inclusion criteria numbered 33, while 69 were excluded due to several reasons: some patients had no HbA1c data, some had no ultrasound results, and others had a history of alcohol consumption. Thus, the total sample obtained consisted of 33 patients.

### Characteristics of Research Samples

In the research that has been done, characteristics samples in research This obtained as following:

**Table 2 Distribution characteristics sample study**

Characteristics	Frequency (n)	Percentage (%)
<b>Gender</b>		
Man	9	27.3
Woman	24	72.7
<b>Age</b>		
18-39 years	1	3.0
40-59 years	21	63.6
60-70 years	11	33.3
<b>Body Mass Index</b>		
<i>Underweight</i>	3	9.1
Normal	5	15.2
<i>Overweight</i>	4	12.1
Obesity I	17	51.5
Obesity II	4	12.1

Based on Table 2, the characteristics show that women were more dominant, with as many as 24 people (72.7%), while men accounted for 9 people (27.3%). In this study, the most dominant age group of respondents was 40–59 years, with 21 people (63.6%), followed by the 60–70 years age range with 11 people (33.3%), while those aged 18–39 years accounted for 1 person (3.0%). In addition, the Body Mass Index (BMI) of patients in this study was found to be most commonly in the obesity I category, with 17 people (51.5%), followed by the normal category with 5 people (15.2%), then the overweight and obesity II categories with 4 people (12.1%), and the underweight category with 3 people (9.1%).

### Analysis Univariate

The results of the research that have been conducted at Waled Regional Hospital, Cirebon Regency based on data from 33 respondents, it was found that results univariate as following:

1. HbA1c value

**Table 3 Distribution frequency HbA1c value**

HbA1c	Frequency (n)	Percentage (%)	Average
Bad ( $\geq 7$ )	19	57.6	
Good ( $< 7$ )	14	42.4	7,427 (5.4-11)
<b>Total</b>	<b>33</b>	<b>100</b>	

Based on table 3 is known that distribution of HbA1c values was found to be the most that is with HbA1c value with category bad as many as 19 people (57.6%), while with category Good obtained as many as 14 people (42.4%).

2. Duration Diagnosed with Diabetes Mellitus Type 2

**Table 4 Distribution frequency duration diagnosed with type 2 diabetes**

Duration diagnosed with type 2 diabetes	Frequency (n)	Percentage (%)
$\geq 5$ years	15	45.5
$< 5$ years	18	54.5
<b>Total</b>	<b>33</b>	<b>100</b>

Based on table 4 is known that distribution patients who have duration diagnosed with type 2 DM with range not enough from 5 years most obtained namely 18 people (54.5%) compared to with duration diagnosed with type 2 DM with range more from 5 years namely 15 people (45.5%)

3. Fatty Liver Disease

**Table 5 Distribution frequency Fatty Liver Disease**

Fatty Liver Disease	Frequency (n)	Percentage (%)
Yes	10	30.3
No	23	69.7
<b>Total</b>	<b>33</b>	<b>100</b>

Based on table 5 is known that distribution patient with category No or not suffer from fatty liver disease obtained more dominant that is as many as 23 people (69.7%), while patient with category yes or suffer from fatty liver disease as many as 10 people (30.3%).

**Bivariate Analysis**

Analysis was conducted to determine the correlation between HbA1c values and the duration of diagnosed type 2 diabetes mellitus with the incidence of fatty liver disease at Waled Regional General Hospital, Cirebon. The bivariate analysis was performed using a computerized system, namely SPSS, by applying Fisher's exact test. The results obtained were as follows:

1. Relationship between HbA1c Value and incident Fatty Liver Disease

**Table 6 Analysis results relationship between HbA1c and incident fatty liver disease**

HbA1c value	Fatty Liver Disease				Total	P value	PR (95% CI)
	Yes		No				
	n	%	n	%			
Bad ( $\geq 7$ )	5	15.2	14	42.4	19		0.737
Good ( $< 7$ )	5	15.2	9	27.3	14	0.707	(0.263-2.063)
<b>Total</b>	<b>10</b>	<b>30.3</b>	<b>23</b>	<b>69.7</b>	<b>33</b>		

Based on table 6 above, obtained the data results are patient with HbA1c value with poor control obtained as many as 5 people (15.2%) experienced fatty liver disease, whereas as many as 14 people (42.4%) did not experience fatty liver disease. Patients with HbA1c value with control Good as many as 5 people (15.2%) experienced fatty liver disease, while patients who do not experience fatty liver disease as many as 9 people (27.3%).

Analysis results from the data above obtained mark p-value that is of 0.707 or ( $p > 0.05$ ) which shows that No obtained existence significant relationship between HbA1c value with incident fatty liver disease.

2. Connection Duration Diagnosed with Diabetes Mellitus Type 2 with Fatty Liver Disease incident

**Table 7 Analysis results connection duration diagnosed with diabetes mellitus type 2 with incident fatty liver disease**

Duration Diagnosed with Type 2 DM	Fatty Liver Disease				Total	P value	PR (95% CI)
	Yes		No				
	n	%	n	%			
≥5 years	8	24.2	7	21.2	15		4,800
<5 years	2	6.1	16	48.5	18	0.020	(1,196-19,266)
<b>Total</b>	10	30.3	23	69.7	33		

Based on table 7 above, obtained the data results are patients who have duration diagnosed with type 2 DM with range more from 5 years obtained as many as 8 people (24.2%) experienced fatty liver disease, whereas as many as 7 people (21.2%) did not experience fatty liver disease.

Patients who have duration diagnosed with type 2 DM with range not enough from 5 years obtained as many as 2 people (6.1%) experienced fatty liver disease, whereas as many as 16 people (48.5%) patients No experience fatty liver disease.

Result of analysis of the above data obtained mark p-value namely 0.020 or ( $p < 0.05$ ) which shows that there is existence significant relationship between duration diagnosed with diabetes mellitus type 2 with incident fatty liver disease with PR value is 4,800 which means that patients who have duration diagnosed with diabetes mellitus type 2 with wider range from The same with 5 years risk 4,800 times experiencing incident fatty liver disease.

**Characteristics of Respondents**

In the research that has been conducted, it was found that most respondents were patients with type 2 diabetes mellitus (DM) who visited Waled Regional General Hospital, with most being female, totaling 24 individuals (72.7%). This is in line with research conducted by Arania et al. (2021), which stated that 72.2% of respondents were female, while 27.8% were male. This may be due to women having higher triglyceride levels, which are considered “bad” cholesterol and are a risk factor for this disease (Barb et al., 2021). A decline in estrogen and progesterone levels in women entering menopause also reduces insulin sensitivity, leading to insulin resistance. This condition influences body fat reserves, which increase along with the release of free fatty acids. Additionally, hormonal processes in women facilitate fat distribution

in the body, making it easier for fat to accumulate, thereby contributing to the higher incidence in women (Chen et al., 2020; Drake et al., 2014).

In this study, it was also found that the largest age group of type 2 DM patients was between 40–59 years, with 21 individuals (63.6%). This is consistent with research conducted by Susanti et al. (2024), which reported that most respondents were over 40 years old (55%) (38). As individuals age beyond 40 years, the body's ability to repair, replace, and regenerate cells and tissues declines. Additionally, increasing age is associated with impaired glucose tolerance due to reduced efficiency in glucose metabolism. Other contributing factors include reduced physical activity, weight gain, decreased muscle mass, and progressive decline in pancreatic  $\beta$ -cell function (Malnick et al., 2022; Vernon et al., 2022).

The highest Body Mass Index (BMI) among type 2 DM patients in this study was in the obesity class I category, with 17 individuals (51.5%). This is consistent with research conducted by Sriwaningsi et al. (2023), which showed that respondents in the obesity category were more likely to experience fatty liver disease (52.5%). Obesity is a risk factor for various diseases such as diabetes mellitus, cardiovascular disease, dyslipidemia, and non-alcoholic fatty liver disease (NAFLD). In obesity, there is a significant decrease in adiponectin levels, which contributes to the development of NAFLD (Setiawan et al., 2021). Additionally, fat accumulation and insulin resistance trigger metabolic dysregulation in obese patients. Insulin resistance alters lipid profiles, increasing triglyceride levels and decreasing high-density lipoprotein (HDL) cholesterol, thereby promoting lipid accumulation in hepatocytes, which leads to NAFLD. This lipid accumulation contributes to oxidative stress in liver tissue, triggering progressive inflammation and resulting in hepatocyte edema and eventual necrosis.

### **The Relationship Between HbA1c Values and the Incidence of Fatty Liver Disease**

In this study, which used Fisher's exact test, the  $p$ -value was 0.707 ( $p > 0.05$ ), indicating no significant relationship between HbA1c levels and the incidence of fatty liver disease in patients with type 2 DM at Waled Regional General Hospital, Cirebon.

These results are consistent with a study by Prathiwinda et al., (2024) conducted at the Diabetes Polyclinic of Ngoerah Denpasar Hospital, Bali, which also found no significant relationship between HbA1c levels and the incidence of non-alcoholic fatty liver disease (NAFLD) in type 2 DM patients. Although different statistical tests were used, the respondent characteristics were similar, and the relatively small sample size limited the ability to represent the overall population (35). Several factors may explain this finding. One is the effect of therapy; patients with high HbA1c levels often receive more aggressive antidiabetic treatment, some of which may reduce the risk of fatty liver disease. Therefore, high HbA1c levels do not necessarily correspond to an increased risk of fatty liver disease. Conversely, some cases show that patients with fatty liver disease may have lower HbA1c levels due to impaired hepatic glycogen storage and gluconeogenesis, leading to reduced blood glucose levels. Furthermore, a study by (Wang et al., 2022) reported that HbA1c is not directly associated with fatty liver disease ( $p = 0.102$ ), indicating no significant difference in HbA1c levels between type 2 DM patients with or without fatty liver disease. This suggests that HbA1c alone is not a sensitive marker for assessing fatty liver risk. A more relevant indicator may be the glycated albumin (GA)/HbA1c ratio, which reflects both short-term and long-term glycemic control and is

closely related to insulin resistance, a key factor in the pathogenesis of fatty liver disease (Antunes et al., 2023).

The relationship between HbA1c and fatty liver disease is influenced by multiple factors. Low HbA1c levels do not necessarily indicate the absence of fatty liver disease, and high HbA1c levels do not always indicate its presence. HbA1c can fluctuate over time and may not accurately reflect the metabolic conditions contributing to fatty liver disease (Feldman et al., 2021; Jha et al., 2023). It reflects average blood glucose levels over approximately 2–3 months but does not capture postprandial glucose spikes, glycemic variability, or acute metabolic stress on the liver ((PERKENI), 2021; Anjani, 2023; Sun & Wang, 2021). Thus, HbA1c is better considered an indirect marker of metabolic dysregulation—such as insulin resistance and obesity—rather than a direct cause of hepatic fat accumulation (Fatmona et al., 2023; Mezil & Ahmed, 2021; Shahjeha & Bhutta, 2024; Zemaitis et al., 2023).

In contrast, this study differs from research conducted by Masroor et al., (2021), which reported a significant association between HbA1c levels and the incidence of fatty liver disease. This relationship may be influenced by several factors, including central obesity. Central obesity contributes to the development of fatty liver disease through increased release of free fatty acids (FFAs) from visceral adipose tissue, which are directly taken up by the liver, leading to hepatic steatosis (Anggraeni et al., 2022; Association, 2020; Sri Rahmi et al., 2022). Additionally, obesity exacerbates insulin resistance and promotes fat accumulation in the liver, amplifying the adverse effects of hyperglycemia and triggering inflammatory processes (Giri Prathiwindya et al., 2024; Nogueira & Cusi, 2024; Tanase et al., 2020).

### **The Relationship Between the Duration of Diagnosis of Type 2 Diabetes Mellitus and the Incidence of Fatty Liver Disease**

In this study, Fisher's exact test yielded a p-value of 0.020 ( $p < 0.05$ ), indicating a significant relationship between the duration of type 2 DM diagnosis and the incidence of fatty liver disease in patients at Waled Regional General Hospital, Cirebon.

These findings are consistent with research by Zaib et al., (2022), which reported a significant association between disease duration and fatty liver disease, with an average diabetes duration of approximately 7 years. The study also found that longer disease duration accelerates the progression of fatty liver disease (Arania et al., 2021; Nurgajayanti et al., 2024). Prolonged type 2 DM increases insulin resistance, which affects adipose tissue and worsens adipocyte dysfunction. This leads to increased lipolysis and the release of adipokines and proinflammatory cytokines such as TNF- $\alpha$  and IL-6, which further sustain insulin resistance. Hepatic insulin resistance enhances de novo lipogenesis (DNL). Increased FFA flux to the liver promotes triglyceride synthesis and accumulation, along with toxic lipid intermediates such as free cholesterol. These processes contribute to mitochondrial dysfunction, oxidative stress, and the production of reactive oxygen species (ROS), as well as endoplasmic reticulum (ER) stress through activation of the unfolded protein response (UPR), ultimately leading to hepatic inflammation (Susanti et al., 2024).

Furthermore, this study aligns with findings by Kanwal et al., (2021), who reported that longer duration of type 2 diabetes mellitus is significantly associated with fatty liver disease. Their study showed that the prevalence of fatty liver disease increases with longer disease duration. Interestingly, 8.5% of patients had diabetes for less than 5 years (Komariah &

Rahayu, 2020), suggesting that even newly diagnosed cases may develop fatty liver disease. Several factors contribute to this, including poor glycemic control (Nora et al., 2025). This is supported by Mukherjee et al. (2024), who identified contributing factors in newly diagnosed patients, including high fat intake, increased BMI, larger waist circumference, and higher waist-to-hip ratio. Elevated total cholesterol, triglycerides, and low-density lipoprotein (LDL) levels also contribute to fatty liver development. These findings indicate that even in newly diagnosed type 2 DM, the presence of central obesity, dyslipidemia, and high-fat dietary patterns can promote hepatic fat accumulation and the development of fatty liver disease.

### **Research Limitations**

In this study there are limitations in data collection, including:

1. This study analyzed the relationship between HbA1c values and the duration of being diagnosed with type 2 diabetes mellitus with the incidence of fatty liver disease, so it has not analyzed other confounding factors such as central obesity, dyslipidemia, diet, consumption of certain drugs, and physical activity which also contribute to the occurrence of fatty liver disease.
2. The number of subjects in this study was relatively limited and the distribution was uneven due to the limited time of the study.

### **CONCLUSION**

Based on research conducted at the Waled Regional General Hospital in Cirebon on the relationship between HbA1c levels and duration of diagnosis of type 2 diabetes mellitus (DM) with the incidence of fatty liver disease, it was found that 69.7% of patients did not experience fatty liver disease, while 30.3% did. The analysis showed no significant relationship between HbA1c levels and the incidence of fatty liver disease ( $p = 0.707$ ), whereas a significant relationship was identified between the duration of type 2 DM diagnosis and fatty liver disease ( $p = 0.020$ ;  $PR = 4.800$ ;  $95\% \text{ CI} = 1.196\text{--}19.266$ ), indicating that longer disease duration increases the risk. These findings suggest that disease duration plays a more critical role than HbA1c levels in the development of fatty liver disease among type 2 DM patients. Future research is recommended to include larger sample sizes, longitudinal study designs, and additional metabolic indicators—such as insulin resistance markers, lipid profiles, and the glycated albumin (GA)/HbA1c ratio—to better clarify causal relationships and improve risk prediction.

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