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The Relationship of HbA1c Levels with Symptoms of Gastroesophageal Reflux Disease (GERD) in Type 2 Diabetes Mellitus Patients at Prof. Dr. Soekandar Mojokerto Hospital

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ABSTRACT

This study aims to investigate the relationship between HbA1c levels and the occurrence of gastroesophageal reflux disease (GERD) symptoms in patients with Type 2 diabetes mellitus (T2DM) at Prof. Dr. Soekandar Hospital, Mojokerto. *The prevalence of GERD in diabetic patients, particularly those with poor glycemic control, is a growing concern globally. The primary objective was to determine whether varying HbA1c levels correlate with the severity of GERD symptoms, as measured using the GERD-Q score. A cross-sectional observational design was employed, with data collected through HbA1c measurements and GERD-Q questionnaires from 52 patients with T2DM. The study utilized both univariate and bivariate analyses, including chi-square tests, to evaluate the relationship between glycemic control and GERD symptoms. The results indicated a significant association between higher HbA1c levels and increased GERD prevalence, with 88.9% of patients in the uncontrolled HbA1c group exhibiting GERD symptoms. The chi-square test revealed a significant p-value of <0.001, confirming a strong correlation between poor glycemic control and GERD incidence. This study highlights the importance of glycemic control in reducing the risk of gastrointestinal complications, particularly GERD, in patients with T2DM. Further research is needed to explore the pathophysiological mechanisms underlying this relationship and to develop targeted clinical interventions.*

Keywords: *DMT2, HbA1c, GERD, GERD-Q, Glycemic control*

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia, or an increase in blood glucose levels above normal thresholds (Baynes, 2015; Kumar et al., 2016; Powers et al., 2022; Sarkar et al., 2019). This disease is a serious problem for Indonesia and the world due to the increasing prevalence over the years (Darmawan et al., 1992; Harmadha et al., 2023; Mboi et al., 2022). The morbidity and mortality rates due to diabetes in Indonesia are projected to increase significantly in the period from 2020 to 2045. The estimated prevalence of diabetes is projected to increase by 75.1% over a 25-year period, with an average growth rate of 3% every year. Meanwhile, the number of deaths due to diabetes and its complications is expected to increase by 117% over the same period, or an average of 4.7% annually. Globally, Indonesia ranks sixth as the country with the highest burden of DM cases in the world (Arokiasamy et al., 2021; Hidayat et al., 2022; Nugrahani et al., 2025).

Clinically, DM is identified as a metabolic disorder rooted in a deficit in insulin secretion or the body's inability to optimize the function of the hormone, leading to glucose dysregulation. This chronic condition manifests when the pancreas fails to supply insulin adequately or when peripheral tissues develop resistance to insulin. Impaired function of endocrine glands in tissues, along with their clinical manifestations, indicates the presence of macromolecular, lipid, and complex molecular metabolic abnormalities. This condition causes the typical signs and symptoms of diabetes and increases the risk of microvascular and macrovascular complications.

The clinical classification of DM is divided into several main categories, namely type 1 diabetes, type 2 diabetes, and gestational diabetes. In addition, there are other specific variants that are triggered by certain factors, such as monogenic diabetes syndromes, diseases of the exocrine pancreas, as well as conditions induced by the use of certain high-risk medications. (American Diabetes Association, 2025)

Type 2 diabetes mellitus (T2DM) is characterized by relative insulin deficiency or the ineffectiveness of insulin in facilitating the entry of glucose into cells. This phenomenon results in body cells experiencing an energy deficit even though glucose levels in the blood circulation are high. This condition reflects a mechanism of insulin resistance, in which cells are unable to respond adequately to insulin, thus triggering the development of hyperglycemia (Paraskevi Farmaki, 2020).

The diagnosis of diabetes can be established through HbA1c level parameters or plasma glucose measurements. Plasma glucose procedures include fasting plasma glucose (FPG) examinations (GDP), the two-hour post-load Oral Glucose Tolerance Test (OGTT) (TTGO), or random plasma glucose measurements. Diagnosis through random glucose measurement is made when accompanied by classic clinical manifestations such as polyuria, polydipsia, and unintentional weight loss, or in emergency conditions such as diabetic ketoacidosis (DKA) (KAD) and hyperosmolar hyperglycemic state (HHS).

The HbA1c test has several advantages over GDP and plasma glucose measurements two hours after OGTT because it does not require fasting, is more stable in the preanalytical phase, and is less affected by daily variations due to stress, dietary changes, and illness. However, its availability is still limited in some regions. (American Diabetes Association, 2025)

Persistent exposure to hyperglycemia in chronic T2DM patients is a major risk factor for the development of vascular complications. This condition systemically triggers damage to blood vessels, both at the microvascular and macrovascular levels. These complications are also a factor contributing to the increased mortality rate in Indonesia (Ong, C., 2022).

Among the many complications, enteric neuropathy emerges as a critical yet often overlooked condition. Diabetic enteric neuropathy is a pathology that interferes with the enteric nervous system (ENS), which plays an important role in regulating gastrointestinal (GI) function. These complications result in various digestive disorders in diabetic patients, significantly impacting their quality of life.

The phenomenon of diabetic neuropathy, including enteric neuropathy, increases as the prevalence of diabetes rises. Epidemiological data show that a significant proportion of individuals with diabetes experience a variety of enteric neuropathy symptoms characterized by a collection of gastrointestinal manifestations. (Fatimah et al., 2024)

Gastroesophageal reflux disease (GERD) is one of the most common GI diseases worldwide. GERD is defined as a condition that occurs as a result of the retrograde flow of gastric acid into the esophagus. Due to its involvement with several organs, such as the esophagus, larynx, and respiratory tract, the disease can present with a variety of symptoms. In clinical practice, more than 70% of diabetic patients report gastrointestinal symptoms. GERD is the most common gastrointestinal problem among T2DM patients, with a prevalence of 60%. However, previous research on the relationship between T2DM and GERD has shown conflicting results, ranging from strong associations to no significant associations. (Notariza et al., 2021).

The primary objective of this study is to examine the relationship between HbA1c levels and the occurrence of gastroesophageal reflux disease (GERD) symptoms in type 2 diabetes mellitus (T2DM) patients at Prof. Dr. Soekandar Regional General Hospital in Mojokerto. The study aims to assess whether different HbA1c levels correlate with the severity of GERD symptoms as measured by the GERD-Q score. Additionally, it seeks to identify potential risk factors that contribute to the development of GERD in diabetic patients, with a focus on the relationship between glycemic control and gastrointestinal symptoms.

METHOD

This study used an observational analytical design with a cross-sectional approach to analyze the correlation between HbA1c levels and the manifestation of GERD symptoms in the DMT2 patient population. Data collection was carried out simultaneously (point in time) through the review of medical records and the filling out of the GERD-Q questionnaire by respondents.

Data collection was carried out by researchers taking HbA1c samples during and giving a GERD-Q questionnaire.

The data management steps taken are

1. Data collection
   a. The researcher distributed the GERD-Q questionnaire directly to the patient.
   b. HbA1c data was obtained through medical records.
2. Coding

   Assign code to variable variations, namely:
   a. HbA1c level □5.7% code 0, HbA1c level 5.7%-6.5% code 1 and HbA1c level □6.5% code 2.
   b. GERD symptoms (GERD-Q score) score <8 is code 0. For a score of >8, the code is 1.
   c. Male sex code 1 and female sex code 2.
   d. Age <45 years old code 1, age 45-59 years old code 2, age >59 years old code 3.
3. Entering

   The data that has been categorized and grouped is entered into the Statistical Package for the Social Science (SPSS) application for processing.
4. Cleaning

   To re-check the data that has been processed.

The data analysis in this study included univariate and bivariate analyses. Univariate analysis was conducted to describe the characteristics of the respondents and to distribute independent variables (HbA1c levels) and dependent variables (GERD symptoms). The data is presented in the form of a frequency distribution table and the size of data concentration, including mean, median, and standard deviation.

Bivariate analysis was applied to test the relationship between independent variables (HbA1c levels) and dependent variables (GERD symptoms). Chi-square assays are used as the primary method with data records meeting the distribution assumptions. If these assumptions are not met such as if there is an expected count value of less than 5 in a table cell—then the Fisher's exact test will be used as an alternative. In addition to testing significance, the study

also calculated the contingency coefficient to measure the strength of the correlation between the two variables.

RESULTS AND DISCUSSION

Univariate Analysis

Univariate analysis is applied to describe the characteristics as well as display a picture of the frequency distribution of each variable under investigation. The age and sex of DM patients were calculated through univariate analysis. In addition, the variables that became the focus of the study, namely the incidence of GERD as measured by GERD-Q and HbA1c levels in DMT2 patients were also calculated and included through univariate analysis.

Distribution of patient age

The distribution of respondents under 45 years old is 7 patients or 13%, 45-59 years old is 20 patients or 39%, age over 59 years has the largest proportion with 25 patients or 48%.

Table 1. Age distribution of respondents

Age	Frequency (n)	Percentage (%)
<45 Years	7	13,5
45-59 Years	20	38,5
>59 Years	25	48
Total	52	100

Source: Data from survey of patients with Type 2 Diabetes Mellitus (DMT2) at Prof. Dr. Soekandar Mojokerto Hospital

Table 2. Average age of respondents

Features	Mean	Median	Min	Max
Age (Years)	58,63	59	27	82

Source: Data from survey of patients with Type 2 Diabetes Mellitus (DMT2) at Prof. Dr. Soekandar Mojokerto Hospital

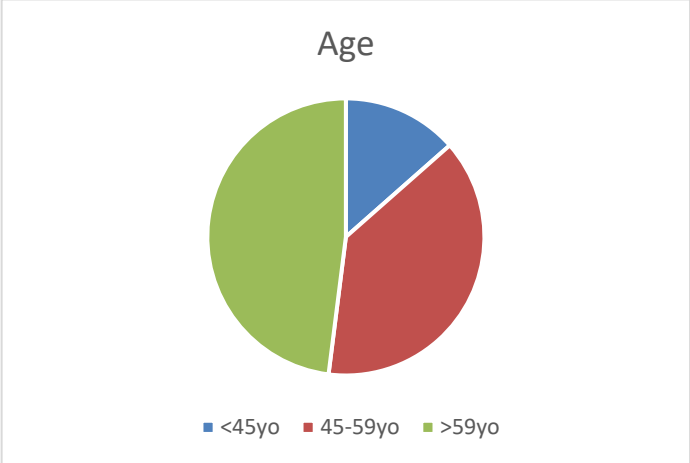

Figure 1. Age distribution of respondents

Gender distribution of respondents

Table 3. Gender distribution of respondents

No.	Gender	Frequency (n)	Percentage
1	Female	35	67,3
2	Male	17	32,7
	Total	52	100

Source: Data from survey of patients with Type 2 Diabetes Mellitus (DMT2) at Prof. Dr. Soekandar Mojokerto Hospital

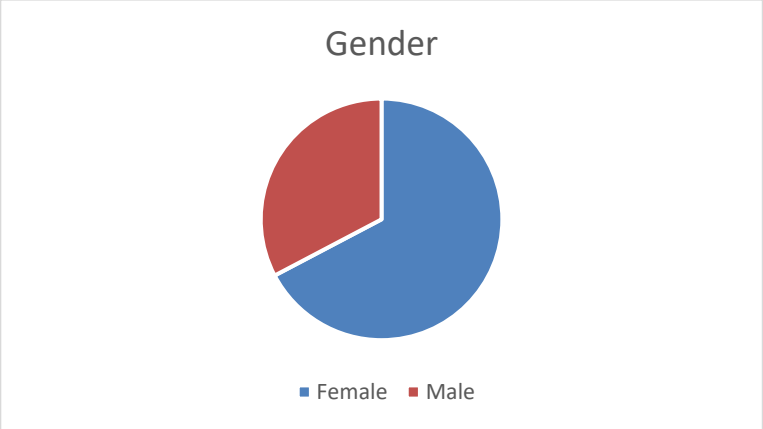

Figure 2. Gender distribution of respondents

Based on the data in Table 3, most of the respondents in this study were female, namely 35 people (67.3%), while male respondents amounted to 17 people (32.7%).

Distribution of HbA1c level data

The distribution of respondents' HbA1c levels is presented in Table 4 and Table 5 and is shown in the form of a pie chart. HbA1c levels were classified into controlled, moderately controlled, and uncontrolled to describe the level of glycemic control of respondents.

Table 4. Sample Characteristics Based on HbA1c Levels

Up to HbA1c	Frequency (n)	Presentase (n)
Controlled	12	23,1
Moderately Controlled	13	25
Uncontrolled	27	51,9
Total	52	100

Source: Medical records of patients with Type 2 Diabetes Mellitus at Prof. Dr. Soekandar Mojokerto Hospital

Table 5. Average HbA1c Levels Sample

Features	Mean	Median	Min	Max
Up to HbA1c	7,89	6,75	4,5	14,7

Source: Data from medical records of Type 2 Diabetes Mellitus patients at Prof. Dr. Soekandar Mojokerto Hospital

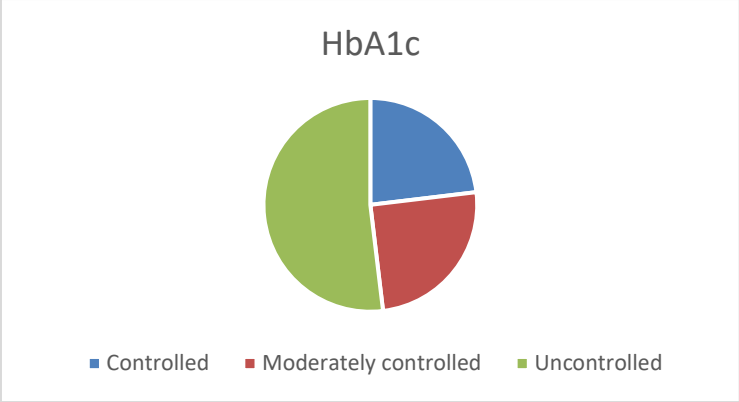

Figure 3. Distribution of HbA1c Levels of Respondents

The categorical data distribution (Table 4) showed that subjects in the Poorly controlled category dominated the proportion with 27 patients (51.9%). Followed by the categories of Moderately Controlled (25%) and Well Controlled (23.1%). The results of the descriptive analysis (Table 5.5) showed that the average HbA1c level of the entire sample was 7.89, with a median value of 6.75.

Distribution of GERD-Q score data

The distribution of respondents' GERD-Q scores is presented in the following table and figure.

Table 6. Sample Characteristics Based on GERD-Q Score

Score GERD-Q	Frequency (n)	Presentase (%)
Non-GERD	23	44,2
GERD	29	55,8
Total	52	100

Source: Data collected via GERD-Q questionnaire administered to Type 2 Diabetes Mellitus patients at Prof. Dr. Soekandar Mojokerto Hospital

Table 7. Average GERD-Q Score

Features	Mean	Median	Min	Max
Score GERD-Q	8,10	8	3	15

Source: Data from GERD-Q scores of patients with Type 2 Diabetes Mellitus at Prof. Dr. Soekandar Mojokerto Hospital

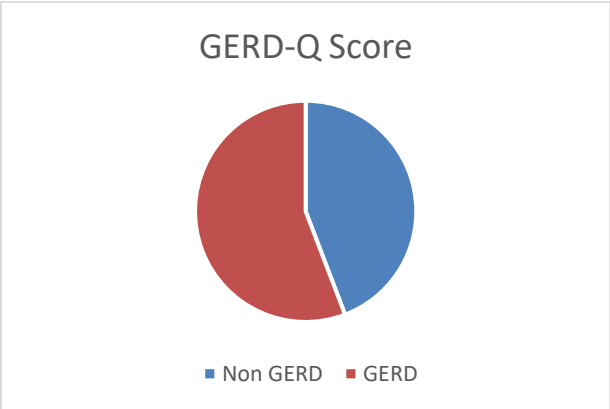

Figure 4. GERD-Q Score Distribution

Based on Table 7 and Figure 4, out of a total of 52 samples investigated, most of the respondents were identified as positive for GERD with a total of 29 people (55.8%). Meanwhile, respondents who were classified as non-GERD amounted to 23 people (44.2%).

Bivariate Analysis

1. Cross-Tabulation between HbA1c and GERD Score

The relationship between HbA1c levels and GERD scores illustrates the distribution of GERD and non-GERD events based on HbA1c level categories in study respondents.

Table 8. Cross-tabulation between HbA1C and GERD Score

HbA1C		GERD	NON-GERD	TOTAL
Controlled (<5.7%)	n	2	12	14
	%	14,7	85,7	100
Moderately Controlled (5,7%-6,4%)	n	3	8	11
	%	27,3	72,7	100
Uncontrolled (≥6,5%)	n	24	3	27
	%	88,9	11,1	100
TOTAL	n	29	23	52
	%	55,8	44,2	100

Source: Data from cross-tabulation analysis of HbA1c levels and GERD-Q scores in Type 2 Diabetes Mellitus patients at Prof. Dr. Soekandar Mojokerto Hospital

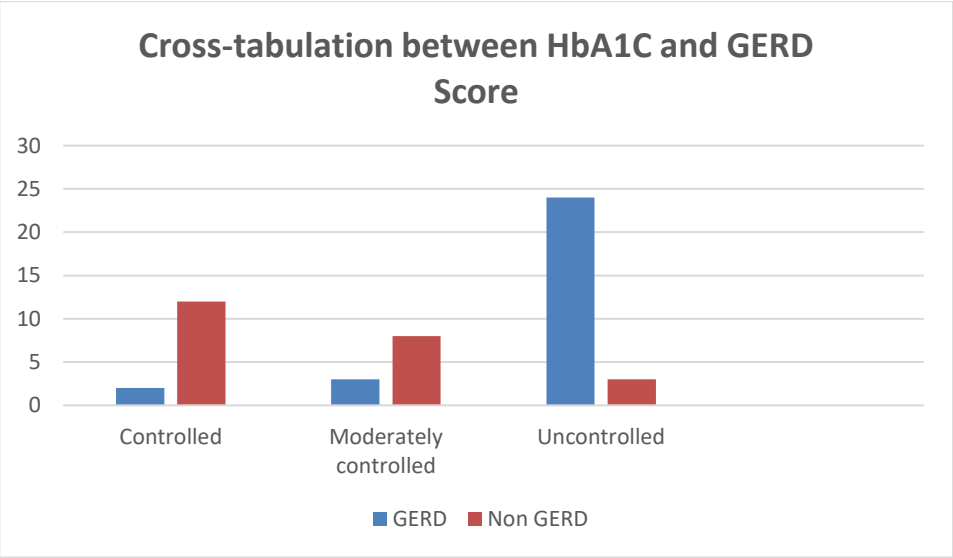

Figure 5. Cross-tabulation of HbA1C with GERD score

The data in Table 5.8 and Figure 5.5 show that of the 14 respondents with well-controlled HbA1c levels (<5.7), most (85.7%) were in the Non-GERD category, while only 2 subjects were identified as having GERD. The moderately controlled group with HbA1c levels (5.7%-6.4%) showed as many as 8 subjects or 72.7% belonging to the Non-GERD category and 3 subjects or 27.3% experienced GERD. The high prevalence was seen in the poorly controlled HbA1c group (≥6.4%), i.e. out of a total of 27 subjects, only 3 patients (11.1%) were included in the Non-GERD category. Most absolutely, i.e. 24 patients (88.9%), had GERD.

Hypothesis Test

The results of the study on the relationship between DMT2 using the HbA1c parameter and GERD using the GERD-Q score parameter using *the Chi-Square* test are as follows:

Table 9. Chi-Square test results for the relationship between DMT2 and the incidence of GERD

HbA1c	Gerd - Q Score				Total		p-value
	Not Gerd		Gerd				
	n	%	n	%	n	%	
Controlled	11	91,7%	1	8,3%	12	100%	0,000
Moderately Controlled	9	69,2%	4	30,8%	13	100%	
Uncontrolled	3	11,1%	24	88,9%	27	100%	

Source: Statistical analysis performed using Chi-Square test on data from Type 2 Diabetes Mellitus patients at Prof. Dr. Soekandar Mojokerto Hospital

Based on table 9, the group with well-controlled HbA1c found only 1 patient with GERD, describing a low prevalence of 8.3% of the total 12 subjects in this group. The prevalence began to increase significantly in the moderately controlled group. In this group, as many as 4 patients or equivalent to 30.8% were diagnosed with GERD. A significant increase from 8.3% to 30.8%. The highest prevalence was in the poorly controlled group of 24 patients or 88.9%.
When sig. □ □ (0.05), then H_0 accept while H_1 reject.
When sig. □ □ (0.05), then H_1 rejected and H_0 accepted.

The results of the chi-square test showed a significance value (p-value) of 0.000, which is smaller than the threshold of a=0.05. This indicates a statistically significant relationship between DMT2 conditions and the risk of GERD events.

This study examined the correlation between HbA1c levels and GERD incidence based on GERD-Q scores in DMT2 patients. The results of the study revealed that poor glycemic control (high HbA1c) was significantly related to the prevalence of GERD symptoms. Chi-square statistical tests confirmed the association, with the prevalence of GERD jumping to 88.9% in the group with poor glycemic control. These findings show that the decrease in the quality of glycemic control is directly proportional to the increased risk of GERD symptoms in patients. This study corroborates the evidence that autonomic dysfunction triggered by chronic hyperglycemia can affect gastrointestinal motility.

Characteristic Analysis

Based on the results of the study, the sample of this study is dominated by the age group of young adults to the elderly, as shown in table 5.2. Most of the subjects were in the age range of more than 45 years with a proportion of 86.5% (45 patients). Dongwon Yi (2016), in his research related to the prevalence and risk factors of GERD in DMT2 patients revealed that the average age of DMT2 patients in his study was (57.7±0.6 years). This age distribution is relevant because old age is a risk factor for the development of DMT2 complications, as stated in a study conducted by Yan et al. (2023) that elderly patients have a high prevalence for diabetes and prediabetes compared to younger patients. Elderly patients are more prone to complications.

One of the complications that elderly patients are prone to suffer from is enteropathy, which is reduced physiological function of the gastrointestinal tract (GIT). In this study, the focus of the reduced physiological function of GIT was esophageal dysfunction, specifically GERD. Shim et al. (2017) revealed that in old age, basal LES pressure tends to decrease, but is not statistically significant. The amplitude of peristaltic contraction was also lower compared to the 49-year-old age group, the results of this study were analyzed using conventional esophageal manometry (Yi, 2016). Other factors such as the use of diabetes medications such as metformin or glucagon-like peptide-1 receptor agonists are associated with an increased risk of gastrointestinal neuropathy in patients with DMT2. (Bajaj et al., 2026)

Analysis of the characteristics of the subjects showed that most of the respondents in this study were female. Based on table 3, as many as 35 respondents or 67.3% of the total sample. This proportion is in line with several epidemiological studies that show that the prevalence of DMT2 tends to be higher in women. According to research by Kautzky-Willer et al. (2016), more than half of diabetics are in the middle age group. The incidence of the disease increases with age in both sexes, with the highest prevalence found in the elderly women's group.

The dominance of female respondents is also relevant to GERD. The prevalence of GERD increases rapidly during the postmenopausal period. The incidence of GERD is closely related to female reproductive hormones. A study conducted in Brazil showed that women reported a significantly higher frequency of symptoms related to GERD (occurring at least twice a week) including heartburn (P = 0.047), burning sensation in the abdomen (P = 0.012), acid regurgitation (P = 0001), dysphagia (P = 0.012), or pain when swallowing (P = 0.009) compared to men. (Kim et al., 2016)

A population-based study of GERD in South China shows that gender has a significant influence on the development of the disease. This was shown that women went to health facilities more often with heartburn complaints (P = 0.032). This means that women's gender is an independent factor. (Kim et al., 2016) The symptoms of GERD can be classified based on the dominant location of origin in the gastrointestinal tract, such as from the esophagus (reflux, dysphagia), stomach (nausea, vomiting, flatulence, pain and discomfort in the abdomen) or intestines (diarrhea, constipation, fecal incontinence). Epidemiological studies show a high prevalence (between 40% to 80%) of upper gastrointestinal symptoms in people with diabetes, especially women, obese, patients infected with Helicobacter pylori, and elderly men. (Arunachala Murthy et al., 2023) The study conducted by AlTassan et al. (2020) revealed that GERD subjects in his study were mostly female, older age, obese, non-smokers, and a higher prevalence of peripheral neuropathy and nephropathy in his univariate analysis. However, at the time of the multivariate test, GERD was found significantly in women with an age of 65 years. Overall, these findings reinforce that autonomic dysfunction triggered by chronic hyperglycemia can affect gastrointestinal motility.

The relationship between HbA1c and GERD

Univariate analysis of the core variables of the study showed a relationship between glucose disorders and GERD. Based on HbA1c levels, most of the study subjects were distributed into high-risk groups, with the poorly controlled category (6.5%) dominating at 51.9% (27 patients). The mean HbA1c of the entire sample was 7.89, which is clinically above the recommended control target for most DM patients, which is 7% for most adults (American Diabetes Association, 2025). This glucose control status creates an environment

that is prone to complications. This is evidenced by the results of GERD screening, where the prevalence of GERD (GERD-Q score 8) was found in 55.8% (29 patients) of the total sample. Showing the probability of the appearance of GERD is increasingly possible in patients with high HbA1c levels. Thus, poor glycemic control plays a role in the pathophysiology of GERD.

The relationship between DMT2 and GERD was proven through bivariate analysis using the chi-square test. The test results on the HbA1c level category and GERD-Q status resulted in an X^2 value of 25.395 with a significance (p-value) of 0.000. Because the number p is far below the threshold (a = 0.05), it means that the null hypothesis (H0) is absolutely rejected. This shows a statistically significant relationship between the HbA1c (Well Controlled, Moderately Controlled and Uncontrolled) categories and the tendency to develop Gastroesophageal Reflux Disease (GERD).

The optimal functioning of the gastrointestinal tract depends on perfectly coordinated peristaltic movements. The regulation of digestive tract motility is carried out through the nervous and endocrine systems, which allows the emergence of physiological synergies of food movement well until the emergence of food elimination. (Kuznik et al., 2020)

Several previous studies have identified a complex relationship between diabetes and an increased risk of GERD, often associated with factors such as autonomic neuropathy and delayed gastric emptying, which are common in diabetic individuals. (Kumar et al., 2024; Kuznik et al., 2020) Diabetic enteropathy is a significant complication that has a multifactorial and complex etiology. Recent data indicate that dysfunction in the enteric nervous system is due to a combination of several pathological mechanisms, including damage to small blood vessels (microangiopathy), autonomic nerve damage, myopathy, polyneuropathy, and changes in the composition of the gut microbiome. All these factors ultimately result in dysmotility in the digestive tract (Reszczyńska & Kempiński, 2021)

GERD is a pathological disorder caused by the rise of gastric contents into the esophagus, often accompanied by symptoms that affect the esophagus, pharynx, larynx, and respiratory tract (Sakti & Mustika, 2022) GERD occurs due to reflux of gastric contents into the esophagus due to lower esophageal sphincter dysfunction (LES). A study conducted by uleh (Kuznik et al., 2020) revealed that the diagnosis of GERD was found in situations of damage to the esophageal mucous membranes or symptom disorders felt by the patient. The main symptom of this disease is a burning sensation in the chest. In developed countries, one in five people report typical symptoms of GERD occurring at least once a week. In DMT2 sufferers, the frequency of symptoms of this disease is much higher. This is due to neuropathy, which reduces LES pressure and delays gastric emptying.

CONCLUSION

This study concludes that there is a significant relationship between HbA1c levels and symptoms of gastroesophageal reflux disease (GERD) in patients with type 2 diabetes mellitus (T2DM) at Prof. Dr. Soekandar Mojokerto Hospital. Statistical analysis using the Chi-Square test showed a significant correlation between HbA1c categories (normal, prediabetic, and diabetic) and the presence of GERD symptoms (p = 0.000). Patients with uncontrolled glycemic status, indicated by HbA1c levels ⩾6.5%, demonstrated a very high prevalence of

GERD symptoms, reaching 88.9%. Furthermore, multivariate analysis revealed that age ⩾59 years and female sex were independent risk factors that significantly influenced the incidence of GERD among T2DM patients in this study. Future research is recommended to involve larger and more diverse populations and to apply longitudinal or prospective study designs to better clarify the causal relationship between long-term glycemic control and the development of GERD, as well as to explore additional factors such as lifestyle, medication use, and duration of diabetes that may contribute to gastrointestinal complications in diabetic patients.

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