

Evaluation of Cardiovascular Risk Biomarkers in Patients with Diabetes Mellitus: A Laboratory-Based Study

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ABSTRACT

Background: Diabetes mellitus (DM) is a major metabolic disorder associated with an increased risk of cardiovascular disease (CVD). Several biochemical and inflammatory markers have been implicated in predicting cardiovascular complications in diabetic patients. Early identification of high-risk individuals using laboratory-based biomarkers can aid in better disease management and prevention of adverse cardiac events. **Objective:** This study aimed to evaluate the role of key cardiovascular risk biomarkers in patients with diabetes mellitus and their association with cardiac complications. **Methods:** A cross-sectional study was conducted on 120 diabetic patients (60 with and 60 without CVD) and 60 age-matched non-diabetic controls. Serum levels of lipid profile parameters (total cholesterol, LDL, HDL, triglycerides), inflammatory markers (high-sensitivity C-reactive protein [hs-CRP] and interleukin-6 [IL-6]), and oxidative stress markers (malondialdehyde [MDA] and total antioxidant capacity [TAC]) were analyzed using automated biochemical assays and ELISA techniques. The atherogenic index of plasma (AIP) and cardiovascular risk ratios were calculated for risk stratification. **Results:** Diabetic patients, especially those with CVD, exhibited significantly higher hs-CRP, IL-6, LDL, triglycerides, and MDA levels compared to both non-diabetic controls and diabetic patients without CVD ($p < 0.001$). AIP and cardiovascular risk ratios were markedly elevated in diabetic patients, correlating with disease duration and glycemic control (HbA1c levels). A strong inverse correlation was observed between HDL and total antioxidant capacity, indicating increased oxidative stress and endothelial dysfunction in diabetic patients. ROC curve analysis demonstrated that hs-CRP (AUC = 0.89) and AIP (AUC = 0.87) had the highest predictive value for cardiovascular risk among diabetic patients. **Conclusion:** The findings suggest that biochemical markers such as hs-CRP, IL-6, lipid profile ratios, and oxidative stress indicators are valuable predictors of cardiovascular complications in diabetic patients. Incorporating these laboratory-based risk markers in routine clinical assessments could improve early detection and risk stratification, aiding in preventive cardiovascular care. Further studies are warranted to establish cut-off values for clinical application.

Keywords: Cardiovascular, Predictors, Diabetes Mellitus

INTRODUCTION

Cardiovascular disease encompasses congenital and acquired conditions affecting the heart and blood arteries, including atherosclerosis, rheumatic heart disease, and vascular inflammation. These disorders contribute significantly to mortality and morbidity. Cardiovascular disease (CVD) poses a significant global public health challenge. Research indicates that individuals with CVD lack comprehensive knowledge about cardiovascular risk factors. In developing countries, where the burden of cardiovascular disease is increasing, data are scarce regarding this issue, impeding the implementation of preventive strategies [1]. Heart diseases are a leading cause of death, particularly in developing countries. In Iraq, heart disease accounted for 18.50% of total deaths in 2017, ranking 19th globally [2]. Cardiovascular risk assessment aims to identify high-risk individuals for future proactive prevention [3]. Evidence gaps on CVD and risk factors are a roadblock to effective cardiovascular disease prevention. As a result, research on patients' understanding of CV risk factors is critical in both primary and secondary CVD prevention. Evidence on patients' understanding of CV risk factors is critical for evidence-based health policy and can aid in the development of personalized. Diabetes patients are more likely to develop cardiovascular disease, which leads to a higher mortality rate. Early risk assessment is critical for initiating cardiovascular risk reduction treatment options therapies [1]. The current study aims to identify cardiovascular risk predictors in patients with diabetes mellitus.

Methodology

A descriptive study design was carried out to predict cardiovascular risk in diabetic patients. A non-probability purposive sample of (101) patients with diabetes who attended the National Centre for Diabetes to seek medical care. The study was conducted at the National Diabetes Center / Mustansiriyah University, which is in Baghdad, Iraq after getting the official administrative arrangements. In 1997, this center was founded in Baghdad to address the growing demand for medical care and specialized follow-up for patients. To accomplish the study, the researchers constructed a close-ended questionnaire format to measure the cardiovascular risk predictors in patients with diabetes mellitus.

The questionnaire included two parts that were distributed as follows: Part I: socio-demographic data sheet; This part concerned personal information of the patients including: (age, gender, level of education, marital status, occupational status, monthly income, and residency). Part II: Clinical data of the patients; This part is about the clinical risks of diabetic patients including (Type of diabetes mellitus, Duration of disease, Type of medication, Committed to diabetes treatment, presence of chronic disease [hypertension, cardiovascular disease, Rheumatic Arthritis, Renal Failure, Retinopathy, and diabetic foot]), (Family history of cardiovascular disease, BMI, height, weight, alcohol drinking and smoking, Exercise regularly, Healthy food, presence of a previous infection, Stress) and laboratory analyses

(Fasting blood sugar, HbA1C, Cholesterol, Triglyceride, HDL-C, and LDL-C). Data collection spanned from February 16, 2022, to May 15, 2022, during patients' routine visits to the center, including appointments with the diabetic physician, dietitian, or laboratory tests. While waiting in the reception area and laboratory, the patient was asked whether they wanted to participate in the study. Once they

agreed, the study terms and procedures were explained, and informed consent was obtained from all patients. While still sitting in the reception area and laboratory, the patient completed the questionnaire. Upon completion, the forms were coded by assigning each patient a number to ensure anonymity and facilitate data capture.

Results

Table 1: Distribution of Participants by their Socio-demographic Data

List	Variable	Frequency	Percentage
1	Age group	18-27	6.9
		28-37	6.9
		38-47	18.8
		48-57	24.8
		58-67	24.8
		68-77	12.9
		78-87	5.0
2	Gender	Male	49.5
		Female	50.5
3	Level of Education	Illiterate	15.8
		Read and write	9.9
		Elementary School	20.8
		Intermediate School	13.9
		High School	11.9
		Diploma	8.9
		Bachelor	12.9
4	Marital Status	Higher education	5.9
		Married	68.3
		Single	9.9
		Widowed	16.8
		Divorced	3.0
		Separated	2.0
		Working	37.6
5	Occupational Status	Not working	20.8
		Student	5.0
		Housewife	36.6
		Sufficient	34.7
6	Monthly Income	Somewhat Sufficient	46.5
		Insufficient	18.8
		Urban	53.5
7	Residency	Suburban	36.6
		Rural	9.9

Table 1 shows that most of the study sample were within the age group (48-57) and (58-67) years old (24.8 %), while most participants were female (50.5 %) and graduated from elementary school (20.8 %). The second part of Table 1 shows that most of the sample were married (68.3 %), working (37.6 %), and with somewhat sufficient monthly income (46.5 %).

Regarding residency (53.5 %) of the sample lived in urban areas. Table 2 illustrates the clinical data of individuals, most of them (64.4 %) have type 2 diabetes. Table 2 displays that nearly half of the participants (41.6 %) have diabetes for about (1-5 years). In concerns of treatment compliance, most of the patients (92.1 %) were committed to treatment.

Table 2: Distribution of Clinical Characteristics of the Study Sample

List	Variable	Frequency	Percentage
1	Type of Diabetes Mellitus	Type I	35.6
		Type II	64.4
2	Duration of Disease	1-5 years	41.6
		6-10 years	22.8
		11-15 years	23.8
		16-20 years	6.9
		21 and above	5.0
3	Are you Committed to Diabetes Treatment?	Yes	92.1
		No	7.9

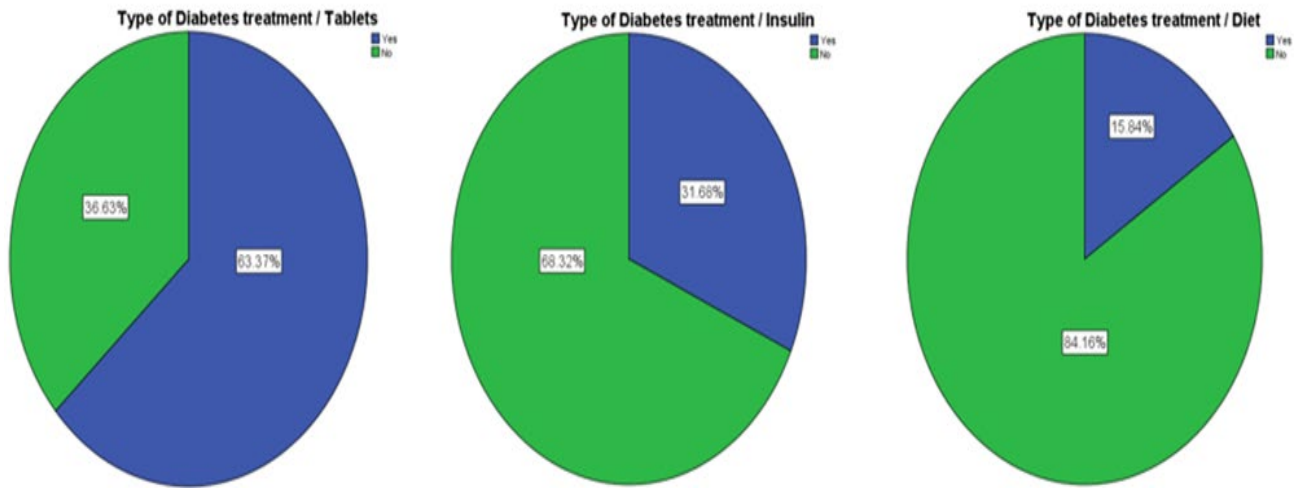
**Figure 1:** Type of diabetic treatment

Figure 1 shows the treatment options for diabetic patients, most of the patients (63.4 %) were committed to oral tablet treatment, while only (31.7 %) of them were taking insulin, and only (15.8 %) of them were on a diet regimen to control diabetes. Regarding chronic diseases, 61.4 %) of diabetic patients were suffering from chronic diseases. About

half of them were suffering from hypertension (49.5 %), while the minority were having Rheumatoid Arthritis (21.8 %), Renal failure (6.9 %), Retinopathy (10.9 %), and only (8.9 %) of the study sample were suffering from Diabetic foot. A family history of cardiovascular disease was found in (57.4 %) only of the sample (Table 3).

Table 3: Distribution of the Presence of Chronic Disease

Chronic Disease	Yes	No
Do You Have Any Chronic Diseases?	61.4	38.6
Hypertension	49.5	50.5
Rheumatoid Arthritis	21.8	78.2
Renal Failure	6.9	93.1
Retinopathy	10.9	89.1
Diabetic Foot	8.9	91.1
Do You Have Any Family History of Cardiovascular Disease?	57.4	42.6

Table 4: Distribution of the Risk Predictors of the Study Sample

List	Variable	Frequency	Percent
1	BMI	18.5-24.9 (Normal)	32.7
		25-29.9 (Overweight)	30.7
		30-34.9 (Obesity class I)	24.8
		35-39.9 (Obesity class II)	5.9
		40 and above (Morbid obesity)	5.9
2	Do You Smoke?	Yes	24.8
		No	65.3
3	Do You Drink Alcohol?	Former smoker	9.9
		Yes	1.0
		No	93.1
4	Do You Exercise Regularly	Previously	5.9
		Yes	9.9
5	Have You Previously Complained of Infections?	No	90.1
		Yes	16.8
6	Is Your Life Suffering from Stress?	No	83.2
		Yes	69.3
		No	30.7
7	Do You Stick to a Healthy Diet	Low Fat	46.5
		Yes	47
		No	53.5
		Low Sugar	68.3
		Yes	69
		No	31.7
		Low Salt	50.5
		Yes	51
		No	49.5

Table 4 shows that (32.7 %) of the participants had a normal body mass index (BMI) between (18.5-24.9), followed by those who were considered overweight person (30.7%) where their BMI level was between (25-29.9). Also demonstrates the distribution of some predictors, regarding smoking, most of the sample (65.3 %) are not smoking, while only (9.9 %) of them were former smokers. Only (1%)

of the sample were drinking alcohol, and about (9.9 %) of them exercise regularly. (16.8 %) of the sample suffered from different types of infections, and (69.3 %) of the total sample experiencing stress in their lives. Regarding diet, about half of the sample (47 %) were eating a low-fat diet, (69%) stuck to a low-sugar diet, and (51%) of them taking a low-salt diet.

Distribution of laboratory Test Results of the Study Sample

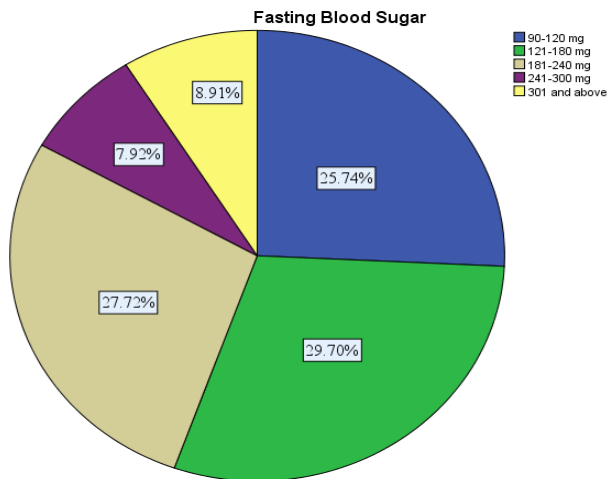


FIGURE 2: Distribution of Fasting Blood Sugar levels

Figure 2 shows that most of the sample (29.7%) had a high level of fasting blood sugar between 121-180 mg.

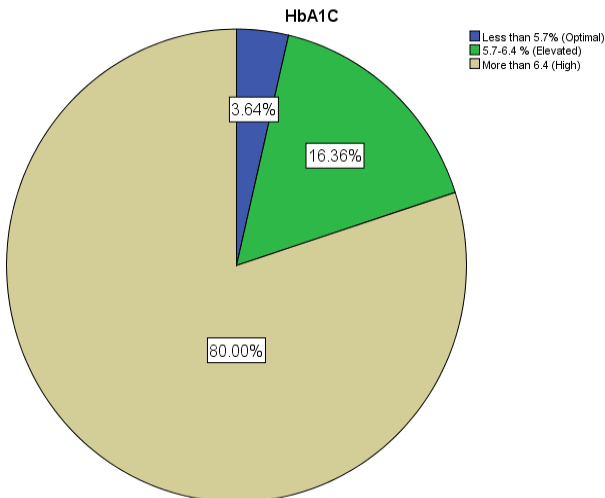


FIGURE 3: Distribution of HbA1C levels

Figure 3 shows that most of the sample (80 %) had a high level of HbA1C, more than 6.4 %.

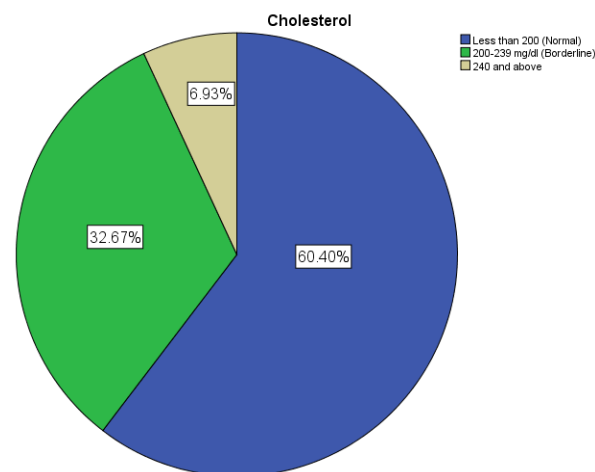


FIGURE 4: Distribution of cholesterol levels

(60.4%) of the sample had a normal level of cholesterol (Less than 200 mg/dl) as shown in Figure 4.

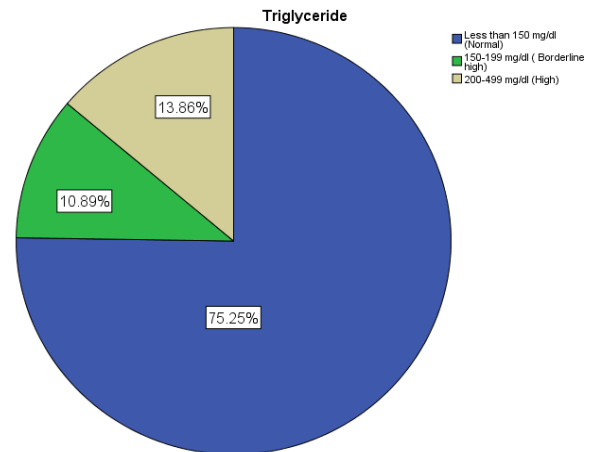


FIGURE 5: Distribution of triglyceride levels

Most of the Triglyceride levels of the sample (75.2) are within normal ranges (Less than 150 mg/dl) as demonstrated in Figure 5

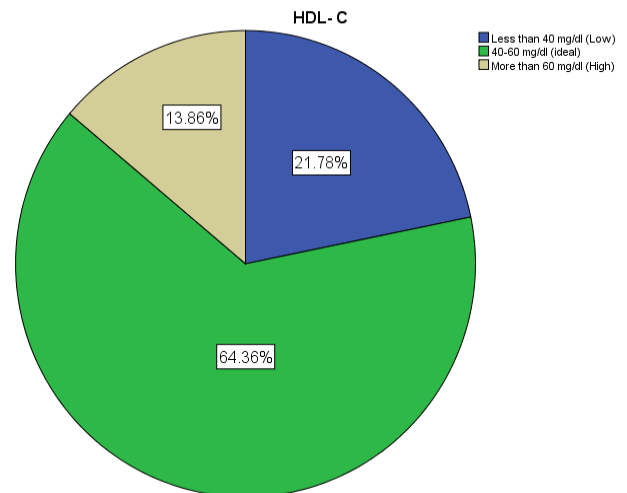


FIGURE 6: Distribution of HDL levels

Figure 6 shows that (64.4%) of the participants had an ideal level of HDL in their results between (40-60 mg/dl).

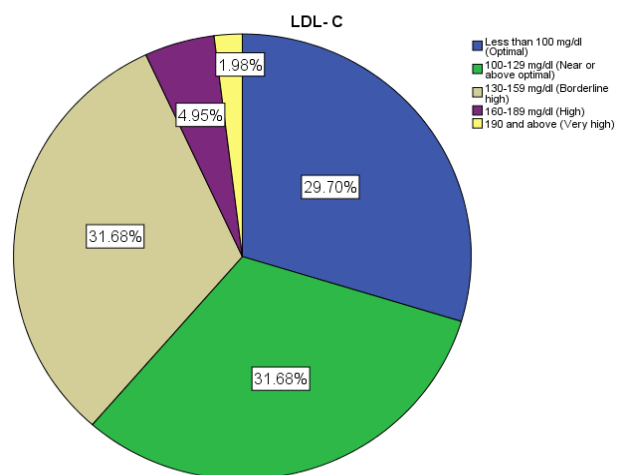


FIGURE 7: Distribution of LDL levels

Figure 7 shows that most of the samples had near or above optimal (100-129 mg/dl) and borderline high levels (130-159 mg/dl) of LDL (31.7 %) for each.

Discussion

According to the study findings, the majority of the sample's age group (24.8%) is between 48-57 and 58-67 years old. This disagrees with a study by Kilkenny [4] which stated most age samples (30%) were 70 or more years old. It also disagrees with study [5] which ranges between 35-44 years (3.7%). It agrees with a study published in Isfahan Province [6] where participants' ages ranged between 56 and 66 years old (20%). It also agrees with study [7] where most participants were aged (31%), ranged between 45 and 69 years old. In terms of gender, the results show that (50.5%) are females and (49.5%) are males. This is consistent with study [7] where (64%) of the females and (36%) of the males. This contradicts study [4] where it reached (45%) of females and (55%) of males. Regarding the participants' educational level, the study discovered that (20.8%) had completed elementary school. This is contrary to study [1] where most participants did not complete their education (28.2%). This contradicts study [7] where most participants were from higher studies (39%). Among the respondents (68.3%) were married. This is like the results of the search [8] which found that most of the samples were married (31%). In respect of occupation, the results of the participants (37.6%) are working. According to the research [1], most of the participants are from the working group (72%). The monthly income according to the results was somewhat sufficient (46.5%). This agrees with research [8] where the results of the monthly income were somewhat sufficient. The results demonstrate that most of the people in the sample live in an urban area (53.5 %) This outcome aligns with the study conducted by researchers [1], which emphasized that most respondents resided in urban areas (90.2%). This result contrasts with the findings of a study conducted by researchers [7] which highlighted that most respondents lived in a rural area (61%). Regarding the type of diabetes, the results showed that most of the participants of the type (64.4%). This result is consistent with research conducted in Ethiopia [9] had more type 2 diabetic patients (70%). This contrasts with the research conducted by the American Diabetes Association [10], where a higher proportion of patients had type 1 diabetes (53%).

The result of the duration of diabetes showed that more participants were from 1-5 years (41.6%). This result differs from study [11] in which the duration of diabetes for most of the participants was 10 years (54.7%). This result is consistent with Study [12] in which the duration of diabetes for most participants was 5 years (40%). Regarding the type of diabetes treatment, it was the result of tablets (63.4%). This result agrees with [13] other research, where the participants were using the tablet treatment (65.1%). As a result of using insulin treatment, most of the participants were not using insulin (68.3%). This is consistent with research [14] where most participants were not using insulin (27.7%). This differs from research [13] where most participants were using insulin (17.8%). This is consistent with research [15] where the majority of participants were using diet therapy (62%). According to the results, most of the participants committed to the treatment (92.1%) [16]. This agrees with the [17] research, where most participants were committed to the treatment (84%). This disagrees with research [1], as most participants were not committed to the treatment (75%). About chronic diseases, the majority of participants have chronic diseases

(61.4%). This is consistent with study [11] where most participants suffer from chronic diseases (79%). Most patients did not have hypertension (50.5%), rheumatoid arthritis (78.2%), renal failure (93.1%), retinopathy (89.1%), or diabetic foot (91.1%). This result is consistent with the research [18] where the majority of participants did not suffer from hypertension (35%), rheumatoid arthritis (20%), renal failure (42%), retinopathy (45%), or diabetic foot (30%). This finding disagrees with research [4] where most participants had hypertension (72%) and renal failure (30%), and the research [14] retinopathy (21.7%). According to the results, most of the participants had a family history of cardiovascular disease (57.4%). This agrees with study [14], most of the participants had a family history of cardiovascular disease (82%). The BMI results were 18.5-24.9 (31.7%). This agrees with study [10], where the body mass index is ≥ 24.9 (34.3%). This agrees with the study [18] the BMI is 23.7 (23.9%). Also, it differs from the research [18] the BMI is 29.5 (35.9%). According to the results of the research, most of the participants are non-smokers (65.3%). Which contradicts research [4] where most of the participants were smokers (60%). It differs from research [7] where the percentage of smokers was few (96%). The results of the participants did not drink alcohol (93.1%). This agrees with research [19] where the majority of the participants did not drink alcohol (51%). It contradicts research [4] where most of the participants drank alcohol (85%). Regarding exercise, the majority of participants do not exercise (90.1%), and this agrees with Research [1] that most of the participants do not exercise (51.6%). Regarding the commitment to healthy food, the results of the research showed that most of the participants did not adhere to low-fat foods (53.5%), while they adhered to low-sugar (68.3%) and low-salt (50.5%) foods. This is consistent with Research¹⁹ in terms of low-fat foods while it differs in terms of adherence to foods low in sugar and low in salt. It showed that most participants are not committed to healthy food (57%).

According to the results of the research, most of the participants do not suffer from infections (83.2%). and this is consistent with research [18], where the percentage of those suffering from infections was very few (11%). Contrasting with [20] research, where a person suffering from infection (95%) is associated with those who have a long duration of diabetes (20-30+ years). According to the results of the research, the percentage of those who suffer from stress (69.3%) agrees with the research [15] where the majority of the participants had stress in their lives. Fasting Blood Sugar from 121-180 mg (29.7%). Research results [10] were from 70-100 mg (95%). Cholesterol: Less than 200 mg (Normal) (60.4%). Research results [14] were 183.9mg (37.3%). Triglyceride: Less than 150 mg (Normal) (75.2%). Research results [13] were 150 mg (Normal) (42.6%). HDL-C from 40-60 mg (ideal) (64.4%). Research results [10] were (Normal) (65.8%). LDL-C from 100-129 mg (Near or above optimal) and 130-159 mg (Borderline high) (31.7%). Research results [10] were 109 mg (50.5%). HbA1C: shows that most of the sample (80 %) had a high level of HbA1C more than 6.4 %. This agrees with another study where their results were high too, with HbA1C (56%) at a rate of (6 to 49 mmol/mol) [21].

Conclusion

Based on the results and discussion, the researcher concludes that most of the study sample falls within the age groups of 48-57 and 58-67, predominantly female, with elementary school education, married,

employed, and living in urban areas. Most participants are non-smokers with a normal body mass index.

In terms of clinical data, over half of the sample had type II diabetes for approximately 1-5 years and primarily used oral medication. A significant portion of them also had a history of chronic diseases and experienced stress. Regarding dietary habits, most participants did not adhere to a low-fat diet, but they generally consumed low-sugar and low-salt diets. The study sample exhibited high levels of Fasting blood sugar, normal cholesterol levels, elevated haemoglobin A1c (HbA1c) levels, ideal HDL-C levels, and high LDL levels. The study results highlight key characteristics of the study sample, including their demographics, clinical data, dietary habits, and laboratory results. These findings suggest potential risk factors for cardiovascular diseases among diabetic patients.

Recommendations

The researchers propose focusing on monitoring and following up with diabetic patients through educational lectures, especially for those with high blood pressure, to detect risk predictors for cardiovascular disease early. They emphasize the importance of annual examinations and education for diabetic patients on cardiovascular diseases through continuous lectures. Raising awareness about periodic diabetes examinations and adhering to a healthy diet can help prevent diabetes progression and subsequent cardiovascular diseases. The researchers also recommend encouraging nursing staff in healthcare settings to participate in educating clients about cardiovascular risk detection in diabetic patients. Holding symposiums can provide necessary information on how to avoid developing cardiovascular diseases, preserve their health, and prevent long-term diabetes complications.

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