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Original article

Predictors of cirrhosis in chronic hepatitis C: Findings from a 24-month follow-up study in Almaty, Kazakhstan

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Abstract. *Background and aim:* Hepatitis C virus (HCV) infection remains a significant global health challenge, affecting an estimated 50 million people worldwide and causing approximately 1 million new cases annually. The presence of cirrhosis and diabetes mellitus appear to amplify the clinical and economic impact of HCV related disease. This study aims to evaluate the incidence of liver cirrhosis within a 24-month follow-up period after HCV diagnosis, as well as its association with diabetes and other prognostic factors. *Methods:* We performed a retrospective analysis of adults with chronic HCV in Almaty, Kazakhstan, using surveillance and medical record data through December 2024. Eligible patients (ICD-10 B18.2) had ≥24 months of follow-up and were assessed for cirrhosis (FibroScan F4) in relation to demographic, clinical, and laboratory factors, including diabetes. Group comparisons and logistic regression identified independent predictors, with statistical significance set at $p < 0.05$. *Results and Conclusions:* In patients with chronic HCV in Almaty, Kazakhstan, diabetes, poor glycemic control, elevated GGT, and low platelet count were independent predictors of cirrhosis, while sustained virological response was protective. These findings highlight the need for integrated antiviral and metabolic management, with tailored monitoring for high-risk patients to reduce disease progression beyond existing dispanserization measures. (www.actabiomedica.it)

Key words: chronic hepatitis C, cirrhosis, predictors, diabetes mellitus, sustained virological response, glycemic control, risk factors, Kazakhstan, follow-up study, liver disease progression

Introduction

Hepatitis C virus (HCV) infection is a major global public health concern. World Health Organization (WHO) estimates indicate that about 50 million people worldwide are living with chronic HCV infection, and approximately 1 million new cases occur each year (1). The disease imposes a substantial economic burden: a 2020 economic model estimated that its elimination could generate cumulative productivity gains of approximately $46.1 billion by 2030 (2). Currently, there is no preventive vaccine for HCV, although direct-acting antiviral medicines achieve cure rates of around 95% after 8-12 weeks of treatment (3). The leading causes of death among individuals with HCV are liver cirrhosis and hepatocellular carcinoma

(1). Increasingly, however, HCV is being recognized as a systemic disease with extrahepatic consequences that could lead to cardiovascular morbidity and mortality (4). Epidemiological studies demonstrate that individuals with HCV infection have a higher prevalence of insulin resistance and T2DM compared with uninfected populations (5). Mechanistic research suggests that viral factors, chronic inflammation, and altered hepatocellular glucose metabolism may contribute to the pathogenesis of glucose intolerance in this population (6,7). The presence of cirrhosis and diabetes mellitus appears to amplify the clinical and economic impact of HCV-related disease (8). In general, the 5-year survival rate for patients with cirrhosis ranges from 23% to 58% (9). Despite this growing body of evidence, there remains limited longitudinal data following HCV diagnosis, particularly in diverse clinical settings and across varying stages of liver disease. Kazakhstan represents a distinct setting for such investigation because chronic HCV is managed within a national dispanser monitoring system, which provides routine scheduled clinical assessments and laboratory testing free of charge. According to the Order of the Minister of Health of the Republic of Kazakhstan dated September 23, 2020, HCV is classified among socially significant diseases, conditions characterized by high prevalence, substantial treatment costs, and state-funded prevention and care as part of the guaranteed package of free medical services (10,11). In Almaty, the incidence rate of HCV increased from 211.4 cases per 100,000 population in 2021 to 233.7 in 2023, representing a 9.6% rise (p = 0.012) (12). The present study aims to address this knowledge gap by evaluating the incidence of liver cirrhosis within a 24-month follow-up period after HCV diagnosis, as well as its association with diabetes and other prognostic factors.

Materials and Methods

Study design and description of the study population

This study employed a retrospective design to analyze predictors of cirrhosis development in patients with chronic HCV infection. Outpatient medical records were reviewed for all adult patients (aged ≥18 years) diagnosed with HCV, based on infectious disease surveillance data from the city of Almaty. Data were obtained from the Salidat Kairbekova National Scientific Center for Healthcare Development for the period ending December 2024. Patient records were identified using the International Classification of Diseases (ICD) codes corresponding to chronic HCV infection (B18.2). Inclusion criteria were confirmed HCV diagnosis, enrollment in HCV dispanser monitoring for at least 24 months, and availability of complete 24 months follow-up data as of December 1, 2024.

Dependent and independent variables

The primary outcome variable was the presence of cirrhosis at 24 months post-diagnosis, categorized as a binary variable ("yes" vs. "no"). Cirrhosis was diagnosed based on FibroScan findings, with an F4 score indicating advanced fibrosis consistent with cirrhosis. The reference group for all analyses was patients without cirrhosis. Independent variables included two groups of variables: demographic/clinical and laboratory parameters. Demographic and clinical characteristics: age (continuous), gender (male/female), body mass index (BMI) categorized as "underweight and normal weight" vs. "overweight and obese" based on a BMI cut-off value of 25, smoking status, alcohol consumption, diabetes mellitus presence (ICD code E11), Hepatitis B virus co-infection, HCV genotype (1, 2, or 3), number of antiviral treatment cycles (0, 1, or 2), and sustained virological response (SVR) achievement. Laboratory parameters: alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin, gamma-glutamyl transpeptidase (GGT), alkaline phosphatase, glucose, hemoglobin, thrombocyte count, red blood cell count, creatinine, urea, and glycated hemoglobin (HbA1c). All laboratory variables were treated as continuous predictors.

Statistical analysis

Descriptive statistics were computed to compare patients with and without cirrhosis. Continuous variables were summarized using means and standard deviations, while categorical variables were presented as frequencies and percentages. Group comparisons were conducted using independent *t*-tests for continuous variables and chi-square tests for categorical variables. Univariable logistic regression analyses were performed to assess the association between individual predictors and cirrhosis status. Variables with $p < 0.05$ in univariable analyses, along with the primary exposure of interest (diabetes), were included in the multivariable logistic regression model to identify independent predictors of cirrhosis. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. All statistical analyses were conducted using RStudio (version 2024.12.1.563) running R (version 4.3.2, 2023-10-31) (13), and statistical significance was set at $p < 0.05$.

Results

Characteristics of the study population

A total of 185 patients diagnosed with chronic HCV infection were evaluated 24 months post-diagnosis. Among these, 56 patients (30.27%) had developed cirrhosis, while 88 patients (47.56%) were diagnosed with diabetes mellitus. Patients with cirrhosis were significantly older than those without cirrhosis (mean age: 56.61 ± 10.67 years vs. 51.55 ± 12.63 years; $p < 0.01$). The cirrhosis group also had a higher proportion of male patients (66.1% vs. 50.4%; $p = 0.04$), individuals with overweight or obesity (69.6% vs. 53.5%; $p < 0.001$), and patients with diabetes mellitus (76.79% vs. 34.88%; $p < 0.001$). No statistically significant differences were observed between the groups in terms of smoking status, alcohol consumption, HBV co-infection, HCV genotype distribution, or the number of antiviral treatment cycles. However, the proportion of patients achieving SVR was significantly lower in the cirrhosis group compared to the non-cirrhosis group (55.4% vs. 69.8%; $p < 0.001$). Laboratory parameters revealed significantly higher levels of gamma-glutamyl transpeptidase, alkaline phosphatase, glucose, urea, and glycated hemoglobin in patients with cirrhosis. Conversely, thrombocyte counts were significantly lower in the cirrhosis group. Detailed comparisons of demographic, clinical, and laboratory characteristics between the two groups are presented in Table 1.

Predictors of the cirrhosis development

Table 2 presents the results of univariable logistic regression analyses assessing the association between age, gender, and BMI with the presence of cirrhosis among patients with chronic HCV at 24 months post-diagnosis. Increasing age was significantly associated with higher odds of cirrhosis development (*OR* = 1.04; 95% CI: 1.01–1.06; $p < 0.001$), indicating that each additional year of age was associated with a 4% increase in the odds of having cirrhosis. Female gender was negatively associated with cirrhosis (*OR* = 0.52; 95% CI: 0.27–0.99; $p = 0.05$) compared to males, suggesting that females had approximately 48% lower odds of developing cirrhosis. Patients classified as overweight or obese had significantly higher odds of cirrhosis (*OR* = 1.99; 95% CI: 1.04–3.96; $p < 0.001$) compared to those with underweight or normal weight status.

Table 3 presents the results of multivariable logistic regression analyses identifying independent predictors of cirrhosis among patients with chronic HCV infection at 24 months post diagnosis. Presence of diabetes mellitus was strongly associated with increased odds of cirrhosis (*AOR* = 6.43; 95% CI: 2.75–16.20; $p < 0.001$). SVR was inversely associated with cirrhosis, indicating that patients who achieved sustained virological response had significantly lower odds of cirrhosis (*AOR*= 0.49; 95% CI: 0.25–0.98; $p = 0.04$) compared to those who did not. Other general characteristics, including smoking, alcohol consumption, HBV co-infection, HCV genotype, and number of antiviral treatment cycles, were not significantly associated with cirrhosis in the adjusted models. Among laboratory parameters, elevated glucose levels (*AOR* = 1.52; 95% CI: 1.29–1.86; $p < 0.001$), increased gamma-glutamyl transpeptidase (*AOR* = 1.01; 95% CI: 1.00–1.02;

Table 1. Demographic, clinical, and laboratory characteristics of patients included in the analysis

Variables	Cirrhosis present (n=56)	Cirrhosis absent (n=129)	p-value
Demographic and clinical characteristics			
Age	56.61 (10.67)	51.55 (12.63)	<0.01
Gender Male Female	 37 (66.1%) 19 (33.9%)	 65 (50.4%) 64 (49.6%)	 0.04
Body mass index Underweight and normal weight Overweight and obese	 17 (30.4%) 39 (69.6%)	 60 (46.5%) 69 (53.5%)	 <0.001
Smoking Yes No	 7 (12.5%) 49 (87.5%)	 9 (7.0%) 120 (93.0%)	 0.34
Alcohol Yes No	 4 (7.1%) 52 (92.9%)	 8 (6.2%) 121 (93.8%)	 0.15
Diabetes Yes No	 43 (76.79%) 13 (23.21%)	 45 (34.88%) 84 (65.12%)	 <0.001
Hepatitis B virus co-infection Yes No	 3 (5.4%) 53 (94.6%)	 8 (6.2%) 121 (93.8%)	 0.21
Hepatitis C genotype 1 2 3	 18 (32.1%) 31 (55.4%)	 37 (28.7%) 3 (2.3%) 48 (37.2%)	 0.37
Antiviral treatment cycles 0 1 2	 13 (23.2%) 40 (71.4%) 3 (5.4%)	 19 (14.7%) 100 (77.5%) 10 (7.8%)	 0.16
Sustained virological response Yes No	 31 (55.4%) 25 (44.6%)	 90 (69.8%) 39 (30.2%)	 <0.001
Laboratory characteristics			
Alanine aminotransferase	64.49 (106.67)	44.19 (42.46)	0.17
Aspartate aminotransferase	45.74 (37.96)	36.81 (16.60)	0.09
Total bilirubin	21.88 (22.12)	20.38 (16.67)	0.65
Gamma-glutamyl transpeptidase	69.90 (63.50)	50.88 (41.34)	0.04
Alkaline phosphatase	95.28 (32.90)	83.69 (32.00)	0.02
Glucose	8.23 (3.49)	5.77 (1.81)	<0.001
Hemoglobin	138.36 (21.19)	134.45 (19.73)	0.241
White blood cells	824.28 (6121.18)	6.40 (2.78)	0.32
Thrombocytes	177.88 (83.68)	235.63 (82.16)	<0.001
Red blood cells	4.87 (0.50)	4.70 (0.52)	0.03
Creatinine	81.92 (23.05)	80.07 (18.12)	0.59
Urea	6.01 (1.66)	5.45 (1.44)	0.03
Glycated hemoglobin	7.71 (1.72)	6.83 (1.56)	0.004

Table 2. Univariable association between age, gender, BMI and cirrhosis development among patients with chronic HCV at 24 months post-diagnosis

Variables	OR (95% CI)	p-value
Age	1.04 (1.01 – 1.06)	<0.001
Gender (Ref. Male) Female	0.52 (0.27 – 0.99)	0.05
Body mass index (Ref. Underweight and normal weight) Overweight and obese	1.99 (1.04 – 3.96)	<0.001

The reference group for the variable 'Cirrhosis' is 'No'. *Abbreviations:* OR – odds ratio; Ref – reference.

Table 3. Predictors of Cirrhosis in patients with chronic Hepatitis C virus at 24 months post-diagnosis

Variables	AOR (95% CI)[1]	p-value
General characteristics of the patients		
Smoking (Ref. No) Yes	1.77 (0.567 – 5.35)	0.31
Alcohol (Ref. No) Yes	0.86 (0.21 – 2.99)	0.82
Diabetes (Ref. No) Yes	6.43 (2.75 – 16.20)	<0.001
Hepatitis B virus co-infection (Ref. No) Yes	0.67 (0.13 – 2.60)	0.59
Hepatitis C genotype (Ref. 1) 2 3	 0.002 (0 – 0.1) 1.17 (0.55 – 2.53)	 0.99 0.68
Antiviral treatment cycles (Ref. 0) 1 2	 0.62 (0.27 – 1.46) 0.40 (0.07 – 1.85)	 0.27 0.30
Sustained virological response (Ref. No) Yes	0.49 (0.25 – 0.98)	0.04
Laboratory characteristics		
Alanine Aminotransferase	1.01 (0.99 – 1.01)	0.14
Aspartate Aminotransferase	1.01 (1.00 - 1.03)	0.10
Total bilirubin	1.01 (0.99 – 1.03)	0.34
Gamma-Glutamyl Transpeptidase	1.01 (1.00 - 1.02)	0.02
Alkaline Phosphatase	1.01 (1.00 - 1.02)	0.12
Glucose	1.52 (1.29 - 1.86)	<0.001
Hemoglobin	1.01 (0.98 – 1.02)	0.54
Thrombocytes	0.99 (0.98 - 0.99)	<0.001
Red blood cells	1.77 (0.93 - 3.47)	0.09
Creatinine	0.99 (0.98 – 1.01)	0.73
Urea	1.21 (0.97 - 1.53)	0.10
Glycated Hemoglobin	1.44 (1.12 - 1.90)	0.01

The reference group for the variable 'Cirrhosis' is 'No'. 1 – Model is adjusted for age, gender and BMI. Abbreviations: AOR – adjusted odds ratio; Ref – reference.

p = 0.02), and higher glycated hemoglobin (*AOR* = 1.44; 95% CI: 1.12–1.90; p = 0.01) were significantly associated with cirrhosis. Conversely, thrombocyte count was inversely associated with cirrhosis (*AOR* = 0.99; 95% CI: 0.98–0.99; p < 0.001), suggesting that lower platelet levels may be indicative of advanced liver disease. No significant associations were observed for alanine aminotransferase, aspartate aminotransferase, total bilirubin, alkaline phosphatase, hemoglobin, red blood cells, creatinine, or urea in the adjusted models.

Discussion

In this retrospective study of 185 patients with HCV infection followed for 24 months in Almaty, Kazakhstan, we identified several predictors of cirrhosis development. The presence of diabetes mellitus was the strongest independent risk factor, increasing the odds of cirrhosis more than sixfold. Conversely, achieving SVR was significantly protective. Higher glucose, elevated gamma-glutamyl transpeptidase and increased glycated hemoglobin levels were independently associated with cirrhosis, whereas higher thrombocyte counts were inversely associated. Thus, our analysis revealed that metabolic dysfunction and incomplete virological suppression are the key drivers of disease progression. The findings of this study are consistent with extensive literature demonstrating the detrimental effect of diabetes and poor glycemic control on liver fibrosis progression in HCV infection. Large cohort studies from Europe, America, and Asia have shown that type 2 diabetes is associated with accelerated progression to cirrhosis (14–16), likely mediated by insulin resistance, oxidative stress, and pro-inflammatory pathways. The observed associations between elevated glucose and HbA1c with cirrhosis align with these mechanistic insights. Furthermore, in our study, 47.6% of patients with HCV were diagnosed with diabetes mellitus within 24 months of their HCV diagnosis. Evidence from the systematic review indicates that HCV infection increases the likelihood of developing type 2 diabetes mellitus T2DM, regardless of liver disease severity (17). As expected, the risk of T2DM is higher in cirrhotic patients compared with those who have non-cirrhotic chronic hepatitis C. In our study 76.8% of patients with cirrhosis had diabetes mellitus. The protective effect of SVR observed in our cohort is consistent with existing evidence showing that achieving SVR reduces the risk of cirrhosis and hepatocellular carcinoma (18,19). Furthermore, a recent meta-analysis demonstrated that liver cirrhosis regresses in patients with HCV following SVR after successful antiviral therapy (20). Epidemiological studies in Kazakhstan show a concerning trend. A meta-analysis on diabetes prevalence reported a steady increase, rising from a pooled mean of 832.2 per 100,000 in 2004 to 3,743.9 per 100,000 in 2021 (21). Moreover, data indicate that dispanserization rates for diabetes and chronic hepatitis C have steadily increased between 2018 and 2024, with a significant upward trajectory (22). However, the COVID-19 pandemic adversely affected diagnosis and continuity of monitoring for both conditions (22), and patient satisfaction with primary care during the pandemic was low (23), further undermining long-term management. The prevalence of diabetes in the country is projected to rise further by 2030 (24). This growing burden of metabolic disease, coupled with chronic viral hepatitis, may compound the risk of liver-related complications and strain the healthcare system unless proactive, integrated interventions are implemented. In the post-pandemic period, patients who experienced severe COVID-19 require greater medical attention irrespective of other risk factors and are at higher risk of subsequent infectious diseases (25). These findings have important implications for clinical practice. First, they highlight the need for integrated management of metabolic comorbidities in HCV-infected patients, particularly stringent glycemic control in those with diabetes or prediabetes. Second, achieving SVR should remain a primary therapeutic goal, but patients with metabolic risk factors may require ongoing hepatological surveillance post-SVR to detect subclinical progression. Finally, our analysis suggests that the standard HCV dispanser monitoring currently applied in Kazakhstan may not be sufficient for optimal disease management. This underscores the need for incorporating stricter and personalized monitoring protocols, particularly for patients with diabetes mellitus, to improve early detection of progression, increase SVR achievement and enhance patient outcomes. Moreover, the 2024 report on

national policies for hepatitis C elimination notes that Kazakhstan is among the countries lacking a routine information system to monitor hepatitis C-related mortality (26). Several limitations should be acknowledged. The retrospective design limits causal inference, and residual confounding from unmeasured factors (e.g., dietary habits, physical activity, socioeconomic status) is possible. FibroScan was the sole modality for cirrhosis diagnosis; while non-invasive and validated, its accuracy may be influenced by inflammation or steatosis. The study population was restricted to a single urban center, potentially limiting generalizability to rural or ethnically diverse populations. We did not assess the impact of antiviral regimen type or adherence, which may influence SVR rates. Nevertheless, the study's strengths include comprehensive clinical and laboratory data, standardized cirrhosis assessment, and adjustment for multiple confounders in multivariable models.

Conclusions

In summary, among patients with chronic HCV infection in Almaty, Kazakhstan, diabetes mellitus, poor glycemic control, elevated GGT, and lower platelet count were independent predictors of cirrhosis at 24 months, while SVR achievement was strongly protective. These results emphasize the dual importance of viral eradication and metabolic risk management in preventing HCV-related liver disease progression. Integrating metabolic screening and control into HCV care pathways, alongside sustained access to antiviral therapy, could reduce cirrhosis burden. In addition, standard HCV dispensary monitoring in Kazakhstan may require adaptation toward a more stringent, personalized approach for patients with diabetes mellitus and HCV to ensure effective long-term disease management. Prospective multicenter studies are warranted to validate these findings, assess the long-term impact of metabolic interventions, and develop risk-stratification tools tailored to post-SVR populations.

Ethic Approval: The study was conducted in accordance with the Declaration of Helsinki and approved by the Local Ethics Committee of Kazakhstan's Medical University (IRB-71-2023, Protocol No. 9, dated 14 May 2025).

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors Contribution: M.B., G.K. and S.S.: Conceptualization; G.K. and D.S.: Methodology; M.B., G.K., G.T. and N.A.: Software; A.K., Z.S., N.A. and S.A.: Validation; M.B. and B.N.: Formal analysis; G.T. and B.N.: Investigation; M.B., G.K. and A.K.: Resources; G.T. and N.A.: Data curation; M.B., G.K., G.T., A.K., Z.S. and S.S.: Writing – original draft preparation; M.B., G.K., G.T., A.K., Z.S., N.A., B.N., S.A., D.S. and S.S.: Writing – review & editing; N.A., S.A. and D.S.: Visualization; N.A., S.A. and S.S.: Supervision; M.B. and G.K.: Project administration; G.T. and S.S.: Funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Supplementary Materials: Table S1. Original Contributions Used for the Analysis.

Abbreviations

The following abbreviations are used in this manuscript:

AOR: Adjusted Odds Ratio
ALT: Alanine Aminotransferase
AST: Aspartate Aminotransferase
BMI: Body Mass Index
CI: Confidence Interval
GGT: Gamma-Glutamyl Transpeptidase
HbA1c: Glycated Hemoglobin
HBV: Hepatitis B Virus
HCV: Hepatitis C Virus
ICD: International Classification of Diseases
OR: Odds Ratio

Ref: Reference
SVR: Sustained Virological Response
T2DM: Type 2 Diabetes Mellitus
WHO: World Health Organization

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ANNEX

Table S1. Original Contributions Used for the Analysis.

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_ gen	ggtp	Alkaline_ phosphatase	glucose	Hb	leucocytes
59	yes	female	overweight and obese	18,1	20,56	20,11	36,8	141,81	18,97	96,00	3,35
62	yes	male	overweight and obese	792,6	239,10	10,30	66,9	179,00	10,92	143,00	7,00
65	yes	female	overweight and obese	10,3	13,58	6,00	34,0	165,00	5,63	147,00	8,21
72	yes	male	underweight and normal weight	19,3	24,52	21,00	32,0	128,00	7,50	154,00	6,80
68	yes	male	overweight and obese	17,5	25,79	26,41	20,1	52,64	8,37	154,00	4,79
74	yes	female	underweight and normal weight	24,6	45,85	16,30	19,6	78,95	6,48	127,00	5,80
73	yes	female	overweight and obese	28,8	21,09	12,90	25,0	87,00	10,62	127,00	2,80
66	yes	male	underweight and normal weight	103,3	57,34	6,20	34,0	76,00	8,03	166,00	9,70
71	yes	female	underweight and normal weight	42,9	43,11	11,60	33,5	113,14	6,10	145,00	4,30
87	yes	male	overweight and obese	34,4	42,30	15,50	35,5	85,00	5,32	114,00	5,80
50	yes	female	underweight and normal weight	22,8	19,78	14,00	18,2	88,67	9,77	145,00	8,30
62	yes	male	underweight and normal weight	33,8	24,86	11,10	22,7	67,00	17,54	171,00	11,80
71	yes	male	underweight and normal weight	29,9	21,96	40,50	35,0	84,00	4,41	148,00	8,00
74	yes	female	overweight and obese	120,1	127,00	29,00	28,0	78,00	7,36	120,00	4,50
51	yes	female	overweight and obese	9,7	15,03	15,85	33,0	76,00	4,83	131,00	6,20
75	yes	male	underweight and normal weight	18,6	20,62	16,10	12,0	77,79	6,17	155,00	9,40
68	yes	male	overweight and obese	30,0	31,63	18,00	16,7	92,14	11,11	153,00	7,40
67	yes	female	overweight and obese	26,0	31,00	4,95	44,8	87,00	8,50	131,00	4,66
47	yes	male	overweight and obese	72,1	118,19	12,00	118,1	109,26	7,15	148,00	10,50
69	yes	female	overweight and obese	17,9	13,40	9,88	54,0	88,00	5,21	128,00	5,15
46	yes	female	underweight and normal weight	43,7	36,39	10,63	67,0	78,00	7,45	97,00	3,07
77	yes	female	overweight and obese	47,0	48,00	42,00	56,0	102,00	9,70	132,00	5,80

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_gen	ggtp	Alkaline_phosphatase	glucose	Hb	leucocytes
60	yes	male	underweight and normal weight	23,0	24,00	12,45	70,0	110,00	6,00	106,00	5,80
45	yes	male	overweight and obese	45,6	35,59	4,20	16,2	113,00	7,67	70,00	7,60
58	yes	female	underweight and normal weight	40,0	44,00	22,20	34,0	67,00	10,00	140,00	9,00
53	yes	female	overweight and obese	44,0	8,90	10,00	37,0	58,00	14,90	111,00	19,12
71	yes	female	overweight and obese	13,6	19,40	6,80	18,6	103,63	6,20	134,00	7,52
73	yes	male	overweight and obese	18,0	25,00	11,00	11,8	107,26	4,66	130,00	4,66
66	yes	female	overweight and obese	22,6	30,11	20,00	31,0	126,53	5,83	137,00	5,20
51	yes	male	overweight and obese	186,0	99,00	35,70	99,0	93,00	7,25	176,00	4,50
54	yes	male	overweight and obese	12,7	35,96	10,20	36,5	83,00	7,04	159,00	6,30
70	yes	male	overweight and obese	58,0	40,00	8,72	53,0	68,00	6,10	160,00	7,57
70	yes	male	overweight and obese	29,5	22,69	10,90	18,0	102,00	7,39	145,00	4,40
80	yes	male	overweight and obese	15,0	19,73	7,40	13,0	112,00	9,81	138,00	5,30
74	yes	female	underweight and normal weight	10,8	23,32	15,00	12,0	90,37	8,08	130,00	5,90
46	yes	male	overweight and obese	131,6	133,24	108,63	23,0	112,00	14,24	165,00	8,30
47	yes	male	underweight and normal weight	101,5	99,70	4,81	187,5	89,00	8,37	155,00	5,00
62	yes	female	overweight and obese	30,7	19,80	10,10	36,0	66,00	9,95	132,00	5,20
57	yes	female	overweight and obese	49,9	38,60	9,90	15,0	73,00	4,47	133,00	6,50
81	yes	male	overweight and obese	82,1	95,10	14,70	37,0	113,00	7,19	140,00	6,70
77	yes	female	overweight and obese	33,5	26,68	12,81	25,0	92,00	6,60	119,00	6,00
66	yes	female	underweight and normal weight	12,7	16,40	8,80	28,0	87,00	5,73	123,00	9,90
74	yes	male	overweight and obese	38,1	27,47	6,64	252,0	115,00	6,74	138,00	6,00
44	yes	male	overweight and obese	10,4	14,30	13,80	17,0	94,00	6,09	148,00	4,20
66	yes	male	overweight and obese	57,9	36,70	5,90	40,7	82,26	6,92	154,00	7,40
69	yes	male	overweight and obese	14,9	17,40	14,50	122,0	96,00	5,17	144,00	9,90

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_ gen	ggtp	Alkaline_ phosphatase	glucose	Hb	leucocytes
69	yes	female	underweight and normal weight	20,8	24,30	11,20	27,0	103,00	7,54	132,00	5,50
43	yes	male	overweight and obese	54,6	37,21	19,66	336,0	76,80	11,04	146,00	6,60
56	yes	female	overweight and obese	29,7	22,90	7,20	33,9	52,33	9,67	134,00	8,30
55	yes	male	overweight and obese	30,5	28,70	17,18	67,3	28,02	4,03	168,00	5,70
52	yes	male	overweight and obese	49,3	68,20	30,30	258,4	157,49	9,81	167,00	8,40
49	yes	male	overweight and obese	203,3	122,45	19,44	107,3	106,13	10,20	168,00	6,90
64	yes	male	overweight and obese	101,8	58,20	11,40	148,0	78,00	9,98	152,00	6,40
60	yes	female	overweight and obese	57,0	45,40	21,00	39,6	135,70	19,80	110,00	4,50
43	yes	male	underweight and normal weight	33,0	33,10	13,00	69,6	176,50	12,10	134,00	7,60
69	yes	female	overweight and obese	19,0	29,50	9,00	34,6	171,20	6,50	136,00	8,70
70	yes	female	overweight and obese	16,0	17,80	24,00	33,0	132,60	8,70	142,00	7,20
58	yes	female	overweight and obese	35,0	34,00	28,00	21,3	57,10	9,40	153,00	5,30
66	yes	female	overweight and obese	67,3	76,00	17,60	20,4	80,40	6,80	117,00	6,50
56	yes	male	overweight and obese	80,0	42,00	13,60	27,6	90,50	9,80	123,00	3,60
61	yes	male	overweight and obese	93,0	18,90	7,60	36,7	78,90	8,90	146,00	10,10
58	yes	female	overweight and obese	43,0	47,60	12,40	35,4	120,10	6,90	147,00	45813,00
57	yes	male	overweight and obese	38,0	24,70	15,70	37,6	87,00	6,00	118,00	6,30
54	yes	female	overweight and obese	56,0	22,00	15,50	20,1	89,20	7,80	134,00	9,00
57	yes	male	overweight and obese	62,0	31,00	13,20	23,0	68,70	14,50	149,00	12,30
46	yes	male	overweight and obese	76,0	30,50	43,40	34,3	87,00	4,80	143,00	8,70
52	yes	female	overweight and obese	65,0	41,00	32,20	26,5	82,10	7,90	132,00	5,80
56	yes	male	overweight and obese	53,0	28,00	16,50	35,4	77,50	5,60	125,00	7,50
61	yes	male	overweight and obese	37,0	31,60	17,80	13,4	80,70	6,90	146,00	9,80
46	yes	female	overweight and obese	26,0	19,80	19,90	19,0	93,40	10,90	148,00	7,60

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_gen	ggtp	Alkaline_phosphatase	glucose	Hb	leucocytes
49	yes	male	overweight and obese	28,0	28,20	6,80	46,7	89,30	9,00	132,00	5,90
55	yes	male	overweight and obese	76,0	32,50	13,20	123,1	112,20	7,60	141,00	11,20
39	yes	female	overweight and obese	16,0	23,40	10,90	56,0	91,20	5,70	131,00	5,70
43	yes	male	underweight and normal weight	71,0	41,20	11,20	69,6	79,40	7,80	112,00	4,30
49	yes	male	underweight and normal weight	65,0	38,30	44,30	58,0	110,20	9,30	127,00	4,20
44	yes	male	overweight and obese	53,0	35,10	14,20	74,3	113,80	6,40	113,00	6,20
57	yes	female	overweight and obese	25,0	18,90	6,50	19,8	121,60	7,80	83,00	7,70
55	yes	female	overweight and obese	59,0	41,70	25,40	36,5	71,20	8,90	132,00	9,70
65	yes	female	overweight and obese	112,0	87,80	12,20	40,2	60,60	9,80	119,00	20,30
53	yes	male	overweight and obese	90,0	49,80	7,60	20,4	109,20	6,90	132,00	8,70
51	yes	male	overweight and obese	29,3	17,90	13,10	15,6	119,60	5,60	126,00	5,60
36	yes	female	overweight and obese	31,2	24,70	23,20	33,4	132,10	6,70	134,00	5,72
39	yes	male	overweight and obese	40,3	24,10	37,80	101,2	95,50	7,60	165,00	5,10
48	yes	female	overweight and obese	44,2	43,20	13,20	38,7	87,60	7,90	153,00	6,70
56	yes	female	overweight and obese	108,0	59,20	9,80	55,6	71,10	6,70	157,00	7,20
63	yes	male	overweight and obese	37,8	30,10	12,20	20,4	113,30	7,30	151,00	4,60
45	yes	male	overweight and obese	26,4	23,90	9,40	17,6	116,70	8,90	141,00	5,20
43	yes	female	overweight and obese	43,7	27,80	14,30	18,9	91,80	8,30	127,00	5,60
63	no	female	underweight and normal weight	22,40	18,60	9,40	32,00	89,60	9,18	132,00	5,20
42	no	female	underweight and normal weight	11,70	16,56	19,57	12,31	115,23	3,52	125,00	4,70
64	no	female	overweight and obese	10,49	33,00	19,47	17,67	86,84	4,30	169,65	4,13
56	no	female	underweight and normal weight	27,18	15,05	20,34	25,44	70,06	5,30	149,20	4,50
38	no	male	underweight and normal weight	44,70	25,50	30,30	69,00	47,00	4,62	179,00	5,10
56	no	female	overweight and obese	20,00	21,60	8,40	28,00	68,00	5,70	136,00	7,70

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_gen	ggtp	Alkaline_phosphatase	glucose	Hb	leucocytes
40	no	male	overweight and obese	56,00	45,00	26,00	36,00	98,70	6,50	123,50	5,40
34	no	male	underweight and normal weight	24,71	20,07	25,76	33,06	69,47	5,83	149,92	6,20
40	no	female	overweight and obese	16,23	20,72	16,04	54,30	85,55	5,79	163,27	5,26
55	no	female	overweight and obese	65,00	34,00	34,00	42,00	89,60	5,80	132,00	5,00
33	no	female	underweight and normal weight	15,40	21,10	8,10	6,00	60,00	5,02	131,00	8,40
59	no	female	overweight and obese	15,70	21,20	7,90	25,10	85,20	3,07	137,00	10,60
55	no	male	underweight and normal weight	24,03	37,68	21,93	152,61	116,98	4,91	105,00	5,00
62	no	male	underweight and normal weight	24,03	37,68	21,93	152,61	116,98	4,91	105,00	5,00
46	no	male	underweight and normal weight	10,56	14,63	8,43	13,34	77,89	3,52	155,00	10,00
51	no	male	overweight and obese	24,03	37,68	21,93	152,61	116,98	4,91	119,00	5,80
39	no	male	underweight and normal weight	24,03	37,68	21,93	152,61	116,98	4,91	119,00	5,80
64	no	male	overweight and obese	48,00	42,00	43,00	150,00	132,50	6,10	154,00	3,90
46	no	male	underweight and normal weight	88,17	36,21	6,47	13,10	95,10	3,79	146,00	5,90
58	no	male	overweight and obese	12,77	25,00	15,70	15,22	145,17	6,13	160,00	7,80
44	no	male	underweight and normal weight	21,79	29,85	10,90	48,00	143,00	5,58	150,00	4,90
44	no	male	underweight and normal weight	24,53	33,34	40,43	52,00	85,93	5,93	173,00	15,90
32	no	male	underweight and normal weight	27,40	30,70	14,10	69,00	69,00	4,44	157,00	6,10
43	no	male	underweight and normal weight	89,63	73,24	16,26	54,54	57,21	3,62	157,00	4,50
40	no	male	overweight and obese	26,30	28,40	12,50	22,00	78,00	4,80	149,00	6,20
49	no	male	overweight and obese	24,30	27,10	14,20	19,50	83,70	4,95	152,00	5,90
43	no	male	underweight and normal weight	94,30	53,40	11,10	61,00	74,00	4,50	157,00	4,80
33	no	female	underweight and normal weight	13,70	16,30	7,60	8,00	54,00	3,45	115,00	5,50
42	no	female	underweight and normal weight	18,72	15,09	25,90	25,87	64,02	4,87	121,00	6,00
59	no	female	underweight and normal weight	12,84	22,22	12,00	54,00	67,50	4,11	120,00	4,40

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_gen	ggtp	Alkaline_phosphatase	glucose	Hb	leucocytes
36	no	female	underweight and normal weight	27,46	27,15	11,13	3,50	43,00	4,28	192,00	3,50
62	no	male	underweight and normal weight	32,00	34,00	26,00	89,00	76,80	5,30	112,00	4,70
63	no	female	overweight and obese	28,00	32,00	29,30	85,00	89,70	5,20	145,00	4,40
42	no	male	underweight and normal weight	25,00	23,00	45,20	112,00	68,50	5,70	103,00	4,90
34	no	female	underweight and normal weight	17,00	31,00	56,20	124,00	54,40	4,10	98,00	5,20
38	no	male	underweight and normal weight	19,00	23,00	33,20	143,00	68,70	3,90	152,00	5,80
46	no	male	underweight and normal weight	27,00	43,00	20,70	123,00	76,80	3,80	132,00	15,60
58	no	female	underweight and normal weight	34,00	45,00	32,00	153,00	81,20	5,60	105,00	3,20
54	no	male	underweight and normal weight	48,00	54,00	16,70	76,00	92,40	5,30	136,00	3,90
63	no	male	underweight and normal weight	51,00	65,00	21,70	56,00	77,40	4,70	94,00	4,20
28	no	female	underweight and normal weight	37,00	48,00	23,10	87,00	39,60	4,60	116,00	4,00
51	no	female	underweight and normal weight	23,00	61,00	15,50	93,00	48,70	6,00	120,00	3,90
41	no	male	underweight and normal weight	28,00	37,00	16,90	96,00	50,80	5,40	160,00	3,60
46	no	female	overweight and obese	47,00	50,00	21,50	126,00	57,70	3,50	122,00	5,30
44	no	male	underweight and normal weight	40,00	49,00	25,70	165,00	50,70	3,70	141,00	5,10
40	no	male	overweight and obese	36,00	56,00	78,00	34,00	56,80	4,10	101,00	4,90
25	no	female	underweight and normal weight	30,00	43,00	45,50	111,00	67,80	4,50	97,00	3,40
41	no	male	underweight and normal weight	41,00	32,00	87,00	64,00	70,40	4,80	103,00	3,90
60	no	female	underweight and normal weight	64,00	38,00	67,40	76,00	54,80	5,30	117,00	4,00
35	no	male	underweight and normal weight	117,90	68,20	12,00	35,00	70,00	5,00	145,00	6,50
63	no	female	underweight and normal weight	72,00	38,20	15,00	38,00	68,00	3,70	139,00	5,70
59	no	female	underweight and normal weight	76,00	56,00	56,90	48,00	89,90	5,70	101,00	4,80
45	no	male	underweight and normal weight	40,50	45,30	10,00	32,00	65,00	4,20	148,00	6,20
45	no	male	overweight and obese	42,80	47,50	11,00	33,00	66,00	5,00	150,00	6,80

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_gen	ggtp	Alkaline_phosphatase	glucose	Hb	leucocytes
53	no	male	underweight and normal weight	80,30	56,60	8,60	40,00	65,00	4,67	161,00	7,80
49	no	male	overweight and obese	78,50	54,20	9,20	38,00	63,00	5,40	158,00	6,50
36	no	female	underweight and normal weight	76,40	52,80	8,80	37,00	62,00	5,00	157,00	6,70
39	no	male	overweight and obese	74,80	51,30	8,50	35,00	60,00	4,80	152,00	6,30
32	no	female	underweight and normal weight	437,10	21,00	8,50	34,00	59,00	4,90	150,00	6,20
40	no	male	underweight and normal weight	45,80	48,20	12,50	33,00	66,00	5,00	145,00	5,90
51	no	male	overweight and obese	46,70	50,50	14,20	35,00	65,00	5,40	142,00	6,20
44	no	male	underweight and normal weight	44,20	46,80	11,80	31,00	64,00	5,20	140,00	5,80
51	no	male	overweight and obese	45,50	47,50	13,50	34,00	63,00	5,80	143,00	6,00
51	no	female	underweight and normal weight	43,90	45,30	12,10	32,00	62,00	5,10	138,00	5,70
59	no	female	overweight and obese	60,76	48,78	12,50	33,00	66,00	5,30	140,00	5,90
39	no	female	underweight and normal weight	71,00	62,00	26,80	69,00	67,80	3,40	98,00	16,40
54	no	male	overweight and obese	17,70	29,00	2,80	35,00	65,00	5,40	145,00	6,20
51	no	female	overweight and obese	44,20	46,80	11,80	31,00	64,00	5,20	142,00	5,80
42	no	female	underweight and normal weight	43,90	45,30	12,10	32,00	62,00	5,10	138,00	5,70
49	no	female	overweight and obese	44,20	46,80	12,50	33,00	66,00	5,00	145,00	5,90
34	no	female	overweight and obese	46,70	50,50	14,20	35,00	65,00	5,40	142,00	6,20
35	no	female	overweight and obese	20,40	31,00	8,57	18,55	133,06	5,20	140,00	5,70
36	no	female	underweight and normal weight	45,50	47,50	13,50	34,00	63,00	6,70	145,00	5,80
63	no	female	underweight and normal weight	57,00	50,00	75,20	87,00	271,00	4,68	125,00	4,60
56	no	male	overweight and obese	45,80	48,20	12,50	33,00	66,00	5,00	145,00	5,90
43	no	male	underweight and normal weight	46,70	50,50	14,20	35,00	65,00	5,40	142,00	6,20
49	no	male	overweight and obese	11,20	14,40	17,73	31,00	64,00	4,20	140,00	5,80
40	no	male	overweight and obese	45,50	47,50	13,50	34,00	63,00	5,80	143,00	6,00

Table S1 (*Continued*)

age	diabetes	gender	bmi_group	ALT	AST	bilirubin_gen	ggtp	Alkaline_phosphatase	glucose	Hb	leucocytes
41	no	male	overweight and obese	56,60	30,30	5,80	32,00	62,00	5,10	138,00	5,70
51	no	female	overweight and obese	44,20	46,80	12,50	33,00	66,00	5,00	145,00	5,90
69	no	male	overweight and obese	46,70	50,50	14,20	35,00	65,00	5,40	142,00	6,20
48	no	female	overweight and obese	44,20	46,80	11,80	31,00	64,00	5,20	140,00	5,70
63	no	female	overweight and obese	45,50	47,50	13,50	34,00	63,00	6,70	145,00	5,80
36	no	male	overweight and obese	57,00	50,00	75,20	93,00	271,00	4,68	125,00	4,60
53	no	female	underweight and normal weight	19,00	35,00	90,20	87,00	87,80	3,70	94,00	3,60
25	no	female	underweight and normal weight	24,00	37,00	46,80	67,00	89,30	3,90	102,00	13,60
63	no	female	underweight and normal weight	35,00	31,00	54,30	60,00	70,50	4,20	99,00	4,50
61	no	male	underweight and normal weight	43,00	45,00	14,80	58,00	67,70	4,00	107,00	4,20
39	no	male	overweight and obese	23,00	28,00	13,50	38,00	73,40	4,30	142,00	5,70
44	no	male	overweight and obese	19,00	22,00	80,50	59,00	78,60	5,10	133,00	5,30
49	no	male	overweight and obese	22,00	19,00	93,10	113,00	81,20	5,60	97,00	3,70
64	no	male	underweight and normal weight	27,00	34,00	84,30	109,00	73,20	5,30	100,00	3,60
43	no	male	underweight and normal weight	28,00	37,00	14,50	161,00	70,40	5,00	136,00	3,70
57	no	male	underweight and normal weight	43,00	31,00	17,80	154,00	67,70	5,20	127,00	4,40
59	no	female	underweight and normal weight	76,00	25,00	13,20	101,00	72,30	5,70	102,00	4,20
45	no	female	underweight and normal weight	83,00	46,00	16,70	164,00	76,90	5,80	118,00	3,80
49	no	male	overweight and obese	112,00	42,00	18,90	132,00	91,90	5,10	148,00	4,30