ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 22(10): 6526-6530 (2026)

©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 22(10)

Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026

DOI: 10.6026/973206300226526

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by P Kangueane
Citation: Mariam *et al.* Bioinformation 22(10): 6526-6530 (2026)

Clinical and socio-demographic factors associated with type 2 diabetes complications in Eastern Saudi Arabia

BiBi Mariam[1, 3, 4,*], Lubna Abdulrahman Al nuaim[1, 3, 4], Tarig Ahmed Karar[1, 2, 3, 4], Najla Ahmed Khateeb[1, 3, 4] & Suchithra Koipurathu Rajappan[2, 3, 4]

[1]Department of Clinical Nutrition, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, Al Ahsa, Saudi Arabia; [2]Department of Basic Science, College of Science and Health Professions, King Saud Bin Abdulaziz University for Health Sciences, Al Ahsa, Saudi Arabia; [3]King Abdullah International Medical Research Center, Al Ahsa 31982, Saudi Arabia; [4]Ministry of National Guard - Health Affairs, Al Ahsa, Saudi Arabia; *Corresponding author

Affiliation URL:
https://cams.ksu.edu.sa/en/

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 6526-6530 (2026)
©Biomedical Informatics (2026)

https://rpms.kaimrc.med.sa
https://onboarding.mngha.med.sa

Author contact:
BiBi Mariam - E-mail: mariamb@ksau-hs.edu.sa
Lubna Abdulrahman Al nuaim - E-mail: nuaimlu@ksau-hs.edu.sa
Tarig Ahmed Karar - E-mail: karart@ksau-hs.edu.sa
Najla Ahmed Khateeb - E-mail: khateebn@ksau-hs.edu.sa
Suchithra Koipurathu Rajappan - E-mail: koipurathus@ksau-hs.edu.sa

Abstract:
Type 2 diabetes mellitus (T2DM) is associated with metabolic abnormalities and chronic complications requiring regular clinical monitoring. Therefore, it is of interest to evaluate the socio-demographic and biochemical profiles in 326 patients with T2DM in Eastern Saudi Arabia. Retrospective medical records were analyzed using descriptive statistics, independent t-tests and one-way analysis of variance. Age ($p=0.005$), marital status ($p<0.001$) and diabetes duration ($p=0.043$) were associated with complication status, while several biochemical and hematological parameters differed significantly by sex. Thus, data shows that integrated assessment of socio-demographic and laboratory characteristics supports clinical monitoring of patients with T2DM.

Keywords: Type 2 diabetes mellitus (T2DM), clinical biomarkers, socio-demographic factors, diabetes complications, Saudi Arabia

Background:
Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by hyperglycemia resulting from impaired insulin secretion, insulin action or both. Current clinical guidance emphasizes appropriate diagnosis and classification of diabetes together with comprehensive medical evaluation and assessment of associated comorbidities **[1, 2]**. In Saudi Arabia, T2DM represents an important health burden associated with multiple lifestyles, metabolic and clinical risk factors **[3, 4]**. Cardiovascular, renal and other vascular complications contribute substantially to the clinical burden of T2DM **[5, 6]**. Socio-demographic characteristics may contribute to differences in the occurrence, management and outcomes of T2DM. Population-based evidence shows variation in T2DM incidence according to age, sex, socio-economic status, geographic remoteness and population background **[7]**. Socio-demographic characteristics have also been associated with diabetes self-care practices and disease management **[8–10]**. Treatment adherence represents another important component of diabetes management and may be influenced by behavioral, clinical and patient-related factors **[11]**. Psychological factors, including depressive symptoms and perceived stress, may further interact with socio-demographic and diabetes-related characteristics **[12]**. Clinical and biochemical profiling provides important information regarding metabolic abnormalities and potential complication risk in patients with T2DM. A large clinical study demonstrated substantial heterogeneity in the anthropometric, clinical and biochemical profiles of patients with T2DM, including gender-related differences in several parameters **[13]**. Sex-based differences have also been reported in the clinical profile and occurrence of diabetes-related complications **[14–16]**. Recent Saudi evidence demonstrates variations in liver, renal, electrolyte and lipid parameters according to glycemic status, supporting the value of biochemical monitoring in T2DM **[17]**. Biomarker research further highlights the potential role of multiple biochemical indicators in evaluating disease status and complications **[18]**. Diabetes-related complications remain important contributors to morbidity and require systematic clinical surveillance **[2, 5 and 6]**. Evidence suggests that complication patterns vary according to sex and other clinical characteristics **[14–16]**. In addition, self-management interventions and peer-support strategies may improve diabetes-related behaviors and selected clinical outcomes **[19, 20]**. International evidence further demonstrates substantial heterogeneity in diabetes complications according to biological, clinical, social, ancestral and geographical determinants **[21]**. Socio-demographic and clinical profiling of patients with diabetes may therefore provide additional insight into disease burden and management needs **[22]**. Therefore, it is of interest to evaluate associations between socio-demographic characteristics, diabetes complication status and biochemical profiles among patients with T2DM receiving care in hospitals and primary health care centers in Eastern Saudi Arabia.

Methodology:
A retrospective hospital-based study was conducted using anonymized electronic medical record data obtained through King Abdullah International Medical Research Center (KAIMRC), Saudi Arabia. The dataset included 326 patients with confirmed T2DM receiving care at hospitals and primary health care centers in Dammam and Al Ahsa, Eastern Saudi Arabia. Patients with confirmed T2DM and complete demographic and laboratory records were included, while records with incomplete demographic or laboratory information were excluded. Socio-demographic and clinical variables included age, gender, nationality, marital status, type of healthcare facility, duration of diabetes and age at diagnosis. Patients were categorized as T2DM with diabetic neuropathy, T2DM with other complications or T2DM without complications. Biochemical and hematological variables included anion gap, alanine aminotransferase (ALT), alkaline phosphatase (ALP), aspartate aminotransferase (AST), blood urea nitrogen (BUN), cholesterol,

creatinine, HDL, LDL, triglycerides, hemoglobin, mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet count and red blood cell (RBC) count. Laboratory measurements were obtained from certified clinical laboratories according to institutional protocols. Ethical approval was obtained from the KAIMRC Institutional Review Board (IRB No. NRA23A-029-07). Data were analyzed using SPSS version 20. Continuous variables were summarized as mean ± standard deviation and categorical variables as frequencies and percentages. Independent t-tests were used for two-group laboratory comparisons, one-way ANOVA for comparisons across multiple groups and appropriate categorical tests for associations with complication status. A p-value <0.05 was considered statistically significant.

Results:

A total of 326 patients with type 2 diabetes mellitus (T2DM) were included in the study. As shown in **Table 1**, the mean age of the participants was 59.57 ± 10.83 years. Males constituted 57.1% (n=186) of the study population, while females accounted for 42.9% (n=140). All participants were Saudi nationals. Most participants were married (84.0%, n=274), followed by widowed (7.7%, n=25), single (5.8%, n=19) and divorced (2.5%, n=8). **Table 2** presents the association between socio-demographic characteristics and diabetes complication status. Age was significantly associated with complication status (p=0.005). Among participants aged 40–59 years, 159 were without complications, while 6 had diabetic neuropathy and 11 had other complications. Among those aged 60–79 years, 115 were without complications, while 6 had neuropathy and 4 had other complications. Marital status was also significantly associated with complication status (p<0.001). Diabetes duration showed a significant association with complication status (p=0.043). In contrast, gender (p=0.861) and age at diagnosis (p=0.093) were not significantly associated with complication status. As shown in **Table 3**, several biochemical and hematological parameters differed significantly between female and male patients. Mean ALT was significantly higher in males than females (26.74 ± 17.64 vs. 21.61 ± 10.02; p=0.002), whereas ALP was significantly higher in females (83.24 ± 30.44 vs. 74.47 ± 26.06; p=0.005). Females also had significantly higher cholesterol (4.33 ± 0.88 vs. 4.11 ± 0.99; p=0.031) and HDL (1.21 ± 0.27 vs. 1.01 ± 0.24; p<0.001). Creatinine was significantly higher in males (92.04 ± 65.26 vs. 69.74 ± 20.43; p<0.001). Hemoglobin, MCH, MCHC and RBC count were significantly higher in males, whereas platelet count was significantly higher in females (all p<0.001). Females were also significantly older than males (61.63 ± 10.73 vs. 58.02 ± 10.66 years; p=0.003). No significant sex differences were observed for anion gap (p=0.070), AST (p=0.470), BUN (p=0.687), LDL (p=1.000), or triglycerides (p=0.067). No statistically significant differences were observed in the evaluated biochemical parameters across the diabetes complication categories. The age distribution of the study population is illustrated in **Figure 1**, with a mean age of 59.57 ± 10.83 years.

Table 1: Socio-demographic characteristics of patients with T2DM

Socio demographics profiles for hospital patients		Frequency (n)	Percentage (%)
Age	Mean ±SD	59.57±10.83	–
Gender	Males	186	57.1
	Females	140	42.9
Nationality	Saudi Arabia	326	100
Marital status	Divorced	8	2.5
	Married	274	84.0
	Single	19	5.8
	Widowed	25	7.7

Table 2: Association between socio-demographic factors and diabetes complications

Socio-demographic variable	Category	T2DM with diabetic neuropathy		T2DM with other complications		T2DM without complications		P value
		F	%	F	%	F	%	
Age	<39 years	0	0	0	0	10	100	0.005*
Age	40_59 years	6	3.4	11	6.3	159	90.3	0.005*
Age	60_79 years	6	4.8	4	3.2	115	92	0.005*
Age	>80 years	2	13.3	4	26.7	9	60	0.005*
Gender	Female	7	5	8	5.7	125	89.3	0.861
Gender	Male	7	3.8	11	5.9	168	90.3	0.861
Marital status	Divorce	0	0	0	0	8	100	p<0.001*
Marital status	Married	13	4.7	11	4	250	91.2	p<0.001*
Marital status	Single	1	5.3	6	31.6	12	63.2	p<0.001*
Marital status	Widowed	0	0	2	8	23	92	p<0.001*
Diabetes duration	<3 years	5	4.9	7	6.8	91	88.3	0.043*
Diabetes duration	3-5 years	6	10.3	5	8.6	47	81	0.043*
Diabetes duration	>5 years	3	1.8	7	4.2	155	93.9	0.043*
Age at diagnosis	<39 years	0	0	0	0	19	100	0.093
Age at diagnosis	40-59 years	9	4.2	12	5.7	191	90.1	0.093
Age at diagnosis	60-79 years	4	4.5	5	5.7	79	89.8	0.093
Age at diagnosis	>80 years	1	14.3	2	28.6	4	57.1	0.093

Table 3: Comparison of biochemical parameters between male and female patients with T2DM

Parameter	Female	Male	t/F	P value
	Mean ± SD	Mean ± SD		
AGAP	14.10±2.15	13.69 ± 1.84	1.83	0.07
Alanine	21.61±10.02	26.74±17.64	-3.08	0.002*
Alkaline	83.24±30.44	74.47±26.06	2.80	0.005*
Aspartate	19.09±7.53	19.98±13.04	-0.72	0.470
BUN	4.89±2.66	5.02±3.01	-0.40	0.687
Cholesterol	4.33±0.88	4.11±0.99	2.17	0.031*
Creatinine	69.74±20.43	92.04±65.26	-3.90	p<0.001*
HDL	1.21±0.27	1.01±0.24	7.06	p<0.001*
Hemoglobin	123.71± 13.61	144.99±14.30	-13.58	p<0.001*
LDL	2.62±0.79	2.62±0.94	0.00	1.000
MCH	27.57±2.68	28.72±2.81	-3.72	p<0.001*
MCHC	322.17±7.35	328.60±9.39	-6.70	p<0.001*
Platelet	293.96±86.83	247.75±60.12	5.67	p<0.001*
RBC group	4.51±0.49	5.08±0.56	-9.57	p<0.001*
Triglyceride	1.40±0.67	1.58±0.97	-1.84	0.067
Age	61.63±10.73	58.02±10.66	3.02	0.003*

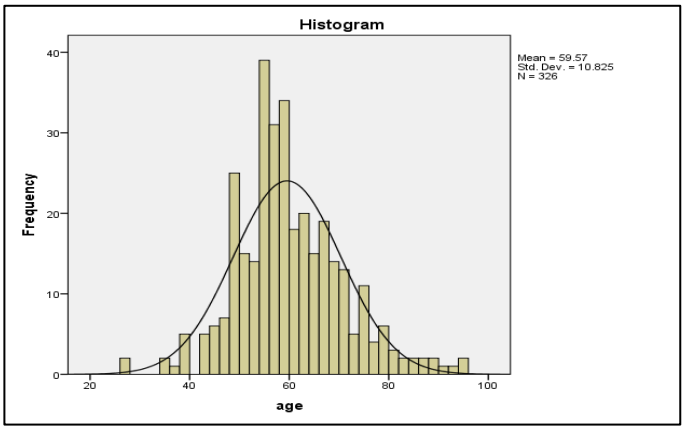


Figure 1: Age distribution of patients with type 2 diabetes mellitus (n = 326). The histogram illustrates the distribution of participants' age (mean ± SD: 59.57 ± 10.83 years), with the superimposed curve representing the normal distribution

Discussion:

The present study describes socio-demographic and biochemical characteristics associated with complication status among patients with T2DM receiving care in Eastern Saudi Arabia. The mean age of approximately 59 years indicates that the study population was predominantly middle-aged and older. Age was significantly associated with complication status (p=0.005), indicating differences in complication distribution across age groups. This observation is consistent with population-based evidence demonstrating variation in T2DM and its outcomes according to age and other socio-demographic characteristics **[7]**. Previous Saudi evidence has also identified increasing age as an important factor associated with diabetes-related vascular complications **[5]**. The findings therefore support the importance of age-related risk assessment during long-term diabetes care **[1, 2]**. Marital status was significantly associated with complication status (p<0.001) in the present study. Although the retrospective design does not permit determination of a causal relationship, social and family circumstances may influence diabetes self-management, treatment adherence and health behaviors. Previous studies have demonstrated associations between socio-demographic characteristics and diabetes self-care practices [**8–10]**. Medication adherence and patient-related treatment factors may also influence diabetes management **[11]**, while socioeconomic and psychological characteristics can affect health and self-management among individuals with T2DM **[12]**. Furthermore, evidence indicates that structured self-management and peer-support interventions may improve self-efficacy, glycemic management and other diabetes-related outcomes **[19, 20]**. Thus, the observed association with marital status should be interpreted as an indication for further investigation rather than evidence of a direct causal effect. Duration of diabetes was also significantly associated with complication status (p=0.043). Longer exposure to chronic hyperglycemia and associated metabolic abnormalities may contribute to the cumulative development of microvascular and macrovascular complications. Previous studies have demonstrated associations between disease duration, metabolic control and diabetes-related complications **[5, 6 and 23]**. Clinical guidelines consequently emphasize continuous assessment of glycemic status, cardiovascular risk, renal function and other comorbidities throughout the course of T2DM **[1, 2]**. Gender was not significantly associated with overall complication status in the present study; however, several biochemical and hematological parameters differed significantly between males and females. ALT and creatinine were higher among males, whereas ALP, cholesterol and HDL were higher among females. Hemoglobin, MCH, MCHC and RBC count were higher among males, while platelet count was higher among females. Recent biochemical evidence similarly demonstrates variation in laboratory profiles among patients with T2DM **[17, 18]**. A large clinical study also identified sex-related differences in clinical and biochemical characteristics among patients with T2DM **[13]**. These findings suggest that biological sex should be considered when interpreting laboratory measurements in diabetes care. The observed sex-related differences are also consistent with broader evidence demonstrating clinically relevant variation in T2DM according to sex **[14]**. Large clinical studies have reported sex differences in clinical characteristics and diabetes-related complications **[15]**, while additional evidence demonstrates sex-related variation in chronic T2DM complications **[16]**. Nevertheless, the absence of a significant association between gender and overall complication status in the present study indicates that sex-related biochemical variation does not necessarily correspond directly to differences in the overall frequency of complications. The clinical importance of laboratory monitoring is further supported by recent studies characterizing biochemical abnormalities in T2DM. Clinical profiling has demonstrated substantial heterogeneity in anthropometric, clinical and biochemical characteristics among patients with diabetes **[13]**, while recent Saudi evidence has demonstrated variations in biochemical parameters according to glycemic status **[17]**. Biomarker research further supports the importance of biochemical indicators in evaluating disease status and potential complications **[18]**. These observations support integrated interpretation of biochemical and hematological

measurements rather than reliance on an isolated laboratory parameter. No statistically significant differences in the evaluated biochemical parameters were identified across the diabetes complication categories in the present study. This finding should be interpreted cautiously because the development of diabetes complications is multifactorial and may depend on disease duration, long-term glycemic exposure, treatment, obesity, cardiovascular risk, lifestyle and other factors **[1–6]**. Evidence from Saudi and international populations similarly indicates that diabetes complications reflect interactions among demographic, metabolic and clinical determinants **[5, 6, 14–16 and 21]**. Therefore, the absence of significant differences in individual biochemical parameters does not diminish their importance in routine clinical monitoring. The present findings collectively support an integrated approach to T2DM assessment incorporate ing socio-demographic characteristics, clinical history and laboratory profiles. Contemporary guidelines emphasize individualized evaluation of comorbidities and risk factors **[1, 2]**, while recent studies demonstrate considerable heterogeneity in diabetes characteristics and complications across populations **[13–16, 21 and 22]**. Incorporating demographic and laboratory information may therefore help clinicians identify patients who require closer monitoring and individualized management. The present study benefits from the use of clinical records from multiple healthcare facilities and the simultaneous assessment of socio-demographic, biochemical and hematological variables. However, its retrospective and hospital-based design limits causal inference and generalizability to the wider population. Information regarding dietary intake, physical activity, socioeconomic status, psychological factors, medication adherence and detailed treatment history was not available, although previous studies indicate that these factors can influence diabetes management and outcomes **[8–12, 19 and 20]**. Future prospective studies incorporating these variables, longitudinal laboratory measurements and larger representative samples are warranted to further characterize determinants of T2DM complications in Saudi Arabia.

Conclusion:

Age, marital status and duration of diabetes were associated with complication status among patients with T2DM in Eastern Saudi Arabia, while several biochemical and haematological parameters differed by sex. No significant biochemical differences were identified across complication categories. Thus, data shows that integrated assessment of socio-demographic and laboratory information may support clinical monitoring and identification of patients requiring closer follow-up.

References:

[1] https://pubmed.ncbi.nlm.nih.gov/41358893/
[2] https://pubmed.ncbi.nlm.nih.gov/41358897/
[3] Alwadeai KS & Alhammad SA. *Medicine (Baltimore).* 2023 **102**:e34021. [PMID: 37327272]
[4] Aldahash R *et al. Endocr Metab Immune Disord Drug Targets.* 2026 **26**:e18715303361062. [PMID: 40183267]
[5] Ahmad MS *et al. Eur Rev Med Pharmacol Sci.* 2021 **25**:4308. [PMID: 34227065]
[6] Karim SI *et al. PLoS One.* 2025 **20**:e0324233. [PMID: 40424347]
[7] Magliano DJ *et al. Med J Aust.* 2024 **221**:473. [PMID: 39354678]
[8] Okafor CN *et al. Nutr Metab Insights*. 2024 **17**:11786388241233534. [PMID: 38481537]
[9] Lan X *et al. BMC Public Health.* 2025 **25**:397. [PMID: 39885509]
[10] Schwarz M *et al. BMC Health Serv Res.* 2024 **24**:1624. [PMID: 39702111]
[11] Silva-Tinoco R *et al. Prim Care Diabetes.* 2022 **16**:780. [PMID: 36127243]
[12] Karki A *et al. Asia Pac J Public Health.* 2024 **36**:719. [PMID: 39257040]
[13] Tripathi P *et al. Sci Rep.* 2025 **15**:10275. [PMID: 40133369]
[14] Kautzky-Willer A *et al. Diabetologia.* 2023 **66**:986. [PMID: 36897358]
[15] Pradeepa R *et al. Healthcare (Basel)*. 2023 **11**:1634. [PMID: 37297774]
[16] Mokhtarpour K *et al. Endocrinol Diabetes Metab.* 2024 **7**:e488. [PMID: 38718275]
[17] Alshalani A *et al. J Clin Med*. 2025 **14**:5324. [PMID: 40806947]
[18] Le TN *et al. Diabetes Obes Metab.* 2025 **27**:7. [PMID: 39355932]
[19] Polsook R *et al. Worldviews Evid Based Nurs.* 2024 **21**:59. [PMID: 37916757]
[20] Chen C *et al. Patient Educ Couns.* 2024 **122**:108172. [PMID: 38320444]
[21] Luk AOY *et al. Diabetologia*. 2025 **68**:2386. [PMID: 40696182]
[22] Obyes AK *et al. Al-Esraa Univ Coll J Med Sci.* 2026 **7**:30. [DOI: 10.70080/2790-7937.1075]
[23] Ewid M *et al. Medicine (Baltimore).* 2023 **102**:e35212. [PMID: 37747025]

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.