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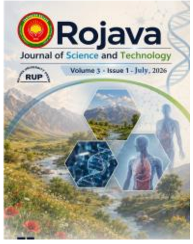

Prevalence and Associated Risk Factors of Diabetes and Prediabetes in North and East Syria: A Cross-Sectional Study

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ABSTRACT

Background: Diabetes and prediabetes are major global health concerns associated with increased morbidity and mortality, particularly in regions affected by conflict where healthcare systems are weakened. Limited epidemiological data exist for North and East Syria, highlighting the need to assess the burden of glycemic disorders and their determinants. Objective: To determine the prevalence of diabetes and prediabetes among adults living in North and East Syria and to identify the clinical risk factors associated with impaired glycemic status. Methods: A cross-sectional study was conducted in North and East Syria. A total of 167 adults were recruited. Data were collected through structured questionnaires, anthropometric measurements, blood pressure assessment, and laboratory investigations. Results: The study demonstrated a considerable prevalence of diabetes and prediabetes, with significant associations between impaired fasting blood glucose and older age, higher body mass index (BMI), increased waist circumference, physical inactivity, smoking, and unhealthy diet. Personal and family histories of hypertension, diabetes, and cardiovascular disease were strongly associated with elevated cardiometabolic risk. Mean arterial pressure, triglycerides, and cholesterol levels showed significant correlations with abnormal glycemic patterns, indicating clustering of metabolic risk factors. Conclusion: Diabetes and prediabetes are highly prevalent among adults in North and East Syria, influenced by multiple demographic, lifestyle, and clinical determinants. These findings provide essential baseline data for developing targeted screening programs, preventive strategies, and public health interventions to reduce the growing burden of diabetes in conflict-affected Syrian communities.

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1. Introduction

Diabetes mellitus (DM) has reached epidemic proportions globally, characterized by a chronic metabolic disorder that arises from either the autoimmune destruction of insulin-producing β-cells or, more commonly, a progressive resistance to insulin action. The International Diabetes Federation (IDF) has projected a continued and disproportionate rise in the Middle East and North Africa (MENA) region, which already faces some of the highest age-adjusted prevalence rates of type 2 diabetes worldwide. This surge is largely attributed to rapid urbanization, an aging population, and a profound shift toward sedentary lifestyles (Sun et al. 2021). The pathophysiology of the disease involves a complex and multifaceted interplay between genetic predisposition and environmental triggers. While the biological mechanisms of insulin resistance, primarily driven by visceral adiposity, lipid accumulation, and systemic chronic low-grade inflammation, are well-documented, they are often exacerbated by hormonal shifts and aging (Lobo et al. 2022). In particular, the transition into states of metabolic syndrome is marked by the secretion of pro-inflammatory cytokines such as TNF-α and IL-6 from visceral adipose tissue, which directly impairs insulin signaling pathways (El Khoudary et al. 2020). The primary objective of this study is to determine the prevalence of diabetes and prediabetes among individuals living in North and East Syria. Furthermore, this study aims to identify demographic, socioeconomic, and lifestyle-related risk factors that are statistically associated with the development of diabetes and prediabetes in this population. The findings will provide insights that can guide healthcare practitioners, policymakers, and public health officials in the formulation of tailored interventions designed to mitigate the impact of diabetes in a conflict-affected situation.

2. Materials and Methods

2.1. Study Design and Setting

An observational cross-sectional study was conducted between December 2024 and June 2025 to determine the prevalence of diabetes and prediabetes in North and East Syria. The study was carried out across five medical centers: Afrin, Tal Rifaat, and Yassin Hospitals in the Aleppo district, and Kobani and Amal Hospitals in the East Euphrates region.

2.2. Participants and Sampling

The target population included Syrian adults aged ≥ 18 years residing in the study regions. The minimum sample size was calculated at 162 participants using EPI-INFO (v.3), based on a 95% confidence interval, 5% margin of error, and an estimated regional diabetes prevalence of 11.9% (World Health Organization [WHO], 2023). A total of 167 participants were enrolled using a convenience sampling method (Pourhoseingholi et al., 2013).

2.3. Data Collection and Tools

Data were collected via structured interviews, clinical examinations, and laboratory analyses.

- Questionnaire: Data were collected on socio-demographics, lifestyle factors, and medical/family history.
- Anthropometric Measurements: Weight, height, and BMI were recorded following standard WHO guidelines (Casadei et al., 2000). Waist circumference thresholds for abdominal obesity were set at ≥ 88 cm for women and ≥ 102 cm for men (Ntuk et al., 2014; WHO, 2008).
- Clinical and Laboratory Assessment: Blood pressure was measured using a mercury sphygmomanometer according to the American College of Cardiology and American Heart Association (ACC/AHA) guidelines (Unger et al., 2020; Writing Committee Members, 2025). Following an overnight fast, venous blood samples were analyzed for fasting blood sugar (FBS), total cholesterol, and triglycerides. Hyperglycemia and prediabetes were defined according to WHO and International Diabetes Federation (IDF) standards (American Diabetes Association, 2024; Unwin et al., 2006).

2.4. Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27 (Arkkelin, 2014). Categorical variables were expressed as frequencies and percentages and compared using Chi-square or Fisher's exact tests. Continuous variables were compared using independent t-tests or ANOVA. Statistical significance was defined as $p < 0.05$.

2.5. Ethical Considerations

The study protocol was approved by the Ethics Committee of Rojava University. Informed written consent was obtained from all participants prior to data collection. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (World Medical Association, 2025).

3. Results

3.1. Demographic and Anthropometric Characteristics

The study included 167 participants (50.9% male, 49.1% female) with a mean age of 49.4 ± 14.6$ years. The mean body mass index (BMI) was 27.9 ± 5.3 kg/m2, and the mean waist circumference was 94.9 ± 13.7 cm. Clinical assessment revealed mean systolic and diastolic blood pressures of 132.1 ± 21.5 mmHg and 85.3 ± 14.7 mmHg, respectively. Metabolic markers showed a mean fasting blood glucose (FBG) of 107.8 ± 45.2 mg/dl and mean triglycerides of 195.8 ± 98 mg/dl.

Table 1: Anthropometric Measurements, Blood Pressure, and Serum Metabolic Profiles of the Studied Population

	Total (N= 167)
Gender	
- Male	85 (50.9%)
- Female	82 (49.1 %)
Age (Mean ± SD)	49.4 ± 14.6
Weight (Kg) (Mean ± SD)	74.4 ± 16.2
Height (m) (Mean ± SD)	1.63 ± 0.11
Waist circumference (cm) (Mean ± SD)	94.9 ± 13.7
BMI (kg/m^2) (Mean ± SD)	27.9 ± 5.3
SBP (mmHg) (Mean ± SD)	132.1 ± 21.5

DBP (mmHg) (Mean ± SD)	85.3 ± 14.7
MAP (mmHg) (Mean ± SD)	100.9 ± 15.7
Fasting blood glucose (mg/dl) (Mean ± SD)	107.8 ± 45.2
Cholesterol (mg/dl) (Mean ± SD)	165.5 ± 34.5
Triglycerides (mg/dl) (Mean ± SD)	195.8 ± 98

SBP = systolic blood pressure, DBP = diastolic blood pressure, MAP = mean arterial blood pressure.

3.2. Prevalence of Diabetes and Cardiometabolic Risk Factors

The prevalence of diabetes was 19.8%, while 16.2% of the population met the criteria for prediabetes. Overall, cardiometabolic risk factors were highly prevalent: 69.5% of participants were overweight or obese, 49.7% had central obesity (high waist circumference), 32.9% were hypertensive, and 61.7% exhibited hypertriglyceridemia.

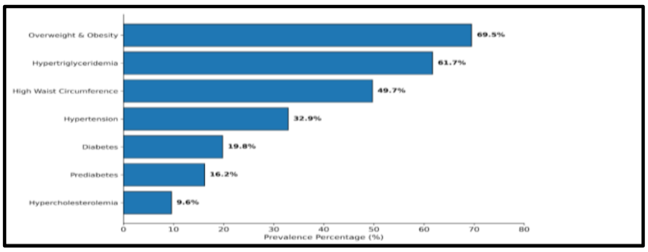

Figure 1: Prevalence of prediabetes, Diabetes, and Associated Cardiometabolic Risk Factors among the studied population.

3.3. Age and Gender-Related Correlations

Age was significantly positively correlated with waist circumference (r = 0.241, p = 0.002), mean arterial pressure (r = 0.204, p = 0.008), and fasting blood glucose (r = 0.182, p = 0.019). Significant gender differences were observed in glucose regulation and obesity patterns. Diabetes was significantly more frequent among females than males (28.1% vs. 11.8%; p = 0.026). Females also showed higher rates of central obesity (63.4% vs. 36.5%; p < 0.001) and clinical obesity (45.1% vs. 25.9%; p = 0.012).

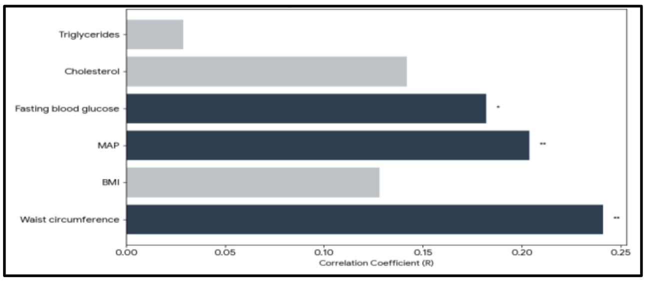

Figure 2: Correlation between age and some anthropometric measurements, blood pressure measurements, and serum metabolic profile of the studied population.

Significant associations in dark blue, ** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed).

3.4. Predictors of Dysglycemia

Blood glucose status was significantly associated with hypertension (p = 0.003) and elevated triglycerides (p < 0.001). Participants with diabetes were significantly more likely to have a high mean arterial pressure (57.6%) compared to normoglycemic individuals (25.2%; p < 0.001). Furthermore, a positive family history of diabetes was strongly associated with current diabetic status (72.7% vs. 40.2%; p = 0.003). In contrast, lifestyle factors such as physical activity, smoking, and dietary habits did not show a statistically significant association with glucose levels in this population (p > 0.05).

Table 2: Correlation between gender and some anthropometric measurements, blood pressure measurements, and serum metabolic profile of the studied population:

	Gender		Test	p-value
	Female (N= 82)	**Male (N= 85)**		
Blood glucose (mg/dl)				
- Normal	48 (58.5%)	59 (69.4%)	X^2	0.026
- Prediabetes	11 (13.4%)	16 (18.8%)	7.126	
- Diabetes	23 (28.1%)	10 (11.8%)		
CMS				
- No CMS	52 (63.4%)	65 (76.5%)	X^2	0.066
- CMS	30 (36.6%)	20 (23.5%)	3.39	
Waist circumference (cm)				
- Normal	30 (36.6%)	54 (63.5%)	X^2	<0.001
- High waist circumference	52 (63.4%)	31 (36.5%)	12.1	
(> 102 cm for male and > 88 cm for female)				
BMI categories				
- Underweight (<18.5)	3 (3.7%)	2 (2.4%)	X^2	0.012
- Normal weight (18.5-24.9)	22 (26.8 %)	24 (28.2%)	8.9	
- Overweight (25-29.9)	20 (24.4%)	37 (43.5%)		
- Obese (30-39.9)	37 (45.1%)	22 (25.9%)		
MAP (mmHg)				
- Normal MAP	55 (67.1%)	57 (67.1%)	X^2	0.99
- High MAP	27 (32.9%)	28 (32.9%)	0.000	
Triglycerides (mg/dl)				
- Normal triglycerides	27 (33%)	37 (43.5%)	X^2	0.111
- Mild high triglycerides	32 (39%)	23 (27.1%)	6.005	
- Moderate high triglycerides	23 (28%)	22 (25.9%)		
- Severe high triglycerides	0 (0%)	3 (3.5%)		

A p-value less than 0.05 indicates a significant association between the variables.

Table 3: Association of Glycemic Status with Demographic, Anthropometric, Clinical, and Lifestyle Risk Factors

	Blood glucose			Test	p-value
	Normal 107 (64 %)	**Prediabetes** 27 (16.2 %)	**Diabetes** 33 (19.8 %)		
Waist circumference (cm)					
- Normal	59 (55.1%)	12 (44.4%)	13 (39.4%)	X^2	0.091
- High waist circumference (> 102 cm for male and > 88 cm for female)	48 (44.9%)	15 (55.6%)	20 (60.6%)	2.943	
BMI categories					
- Normal weight (18.5-24.9)	35 (32.7%)	9 (33.3%)	*7 (21.2%)*	X^2	
- Overweight (25-29.9)	39 (36.4%)	6 (22.2%)	*11 (33.3%)*	*4.625*	0.098
- Obese (30-39.9)	33 (30.8%)	12 (44.4%)	*15 (45.5%)*		
MAP (mmHg)					
- Normal MAP	80 (74.8%)	18 (66.7%)	*14 (42.4%)*	X^2	
- High MAP	27 (25.2%)	9 (33.3%	*19 (57.6%)*	11.947	<0.001
Cholesterol (mg/dl)					
- Normal	99 (92.5%)	23 (85.2%)	*29 (87.9%)*	X^2	
- High	8 (7.5%)	4 (14.8%)	*4 (12.1%)*	1.647	0.312
Triglycerides (mg/dl)					
- Normal triglycerides	47 (43.9%)	11 (40.7%)	*6 (18.2%)*	X^2	
- Mild high triglycerides	38 (35.5%)	6 (22.2%)	*11 (33.3%)*	13.57	<0.001
- Moderate high triglycerides	21 (19.6%)	9 (33.3%)	*15 (45.5%)*		
- Severe high triglycerides	1 (0.9%)	1 (3.7%)	*1 (3.0%)*		
History of diabetes					
- No	102 (95.3%)	22 (81.5%)	*4 (12.1%)*	X^2	<0.001
- Yes	5 (4.7%)	5 (18.5%)	*29 (87.9%)*	99.973	
Family history of diabetes					
- No	64 (59.8%)	16 (59.3%)	*9 (27.3%)*	X^2	0.003
- Yes	43 (40.2%)	11 (40.7%)	*24 (72.7%)*	*11.190*	
History of hypertension					
- No	69 (64.5%)	13 (48.1%)	*12 (36.4%)*	X^2	0.003

- Yes	38 (35.5%)	14 (51.9%)	*21 (63.6%)*	8.974	
Family history of hypertension - No - Yes	43 (40.2%) 64 (59.8%)	14 (51.9%) 13 (48.1%)	*9 (27.3%)* *24 (72.7%)*	X^2 3.809	0.349
History of CVD - No - Yes	81 (75.7%) 26 (24.3%)	21 (77.8%) 6 (22.2%)	*18 (56.3%)* *14 (43.8%)*	X^2 5.137	0.056
Family history of CVD - No - Yes	63 (58.9%) 44 (41.1%)	17 (63%) 10 (37%)	*18 (54.5%)* *15 (45.5%)*	X^2 0.439	0.758
Education level - No - Low - High	26 (24.3%) 68 (63.6%) 13 (12.1%)	5 (18.5%) 19 (70.4%) 3 (11.1%)	*13 (39.4%)* *18 (54.5%)* *2 (6.1%)*	X^2 4.414	0.120
Smoking - No - Yes	54 (50.5%) 53 (49.5%)	14 (51.9%) 13 (48.1%)	*20 (60.6%)* *13 (39.4%)*	X^2 1.049	0.335
Alcohol - No - Yes	97 (90.7%) 10 (9.3%)	21 (77.8%) 6 (22.2%)	*31 (93.9%)* *2 (6.1%)*	X^2 4.669	0.994
Physical activity - No - Yes	55 (51.4%) 52 (48.6%)	12 (44.4%) 15 (55.6%)	*15 (45.5%)* *18 (54.5%)*	X^2 0.636	0.480
Diet - Healthy - Unhealthy - Mixed	4 (3.7%) 4 (3.7%) 99 (92.5%)	2 (7.4%) 1 (3.7%) 24 (88.9%)	*0 (0%)* *0 (0%)* *33 (100%)*	X^2 3.738	0.287

A p-value of less than 0.05 indicates a significant association between the variables.

4. Discussion

The findings of this study reveal an alarming burden of metabolic dysfunction in North and East Syria, with an overt diabetes prevalence of 19.8% and a prediabetes prevalence of 16.2%. Combined, over one-third of the studied adult cohort (36.0%) exhibits impaired glucose regulation. This is substantially higher than the global adult diabetes prevalence baseline of 10.5% reported by the International Diabetes Federation (Sun et al. 2021) and sits at the upper end of estimates across the Middle East and North Africa (MENA) region, which typically range between 12% and 19% (World Health Organization 2023a). This high prevalence of dysglycemia does not occur in isolation; rather, it is embedded within a profound clustering of cardiometabolic risk factors. In this cohort, 69.5% of participants were overweight or obese, 49.7% exhibited central obesity, 32.9% were hypertensive, and 61.7% suffered from hypertriglyceridemia. This severe constellation of health issues underscores a regional epidemic of metabolic syndrome, highlighting a highly vulnerable population group that faces substantial future cardiovascular and microvascular complications (World Health Organization 2023b). The close, statistically significant intersection between blood glucose status, high mean arterial pressure (MAP), and hypertriglyceridemia is driven by overlapping, well-established cellular and endocrine pathways. Visceral adipose tissue, which was highly elevated in this cohort as indicated by a mean waist circumference of 94.9 cm, is metabolically active and highly lipolytic. It floods the portal circulation with free fatty acids (FFAs) and releases pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) (El Khoudary et al. 2020). These molecules inhibit insulin receptor substrate-1 (IRS-1) signaling in skeletal muscle and hepatic tissues, causing systemic insulin resistance. In the liver, insulin resistance stimulates excessive de novo lipogenesis and impairs the inhibitory effect of insulin on very-low-density lipoprotein (VLDL) secretion. Concurrently, endothelial lipoprotein lipase (LPL) activity is suppressed, resulting in the severe hypertriglyceridemia (61.7%) observed in this population. Chronic hyperglycemia and insulin resistance stimulate blood pressure elevation via several distinct pathways. Hyperinsulinemia acts as a chronic activator of the sympathetic nervous system (SNS) and the renin-angiotensin-aldosterone system (RAAS), driving renal sodium retention and expanding intravascular volume. Simultaneously, advanced glycation end-products (AGEs) and secondary oxidative stress impair endothelial nitric oxide synthase (eNOS) activity. This loss of nitric oxide-mediated vasodilation elevates vascular stiffness and systemic vascular resistance, directly explaining why 57.6% of the diabetic sub-cohort presented with high mean arterial pressure (World Health Organization 2023c). Beyond primary dietary factors, the unique humanitarian context of North and East Syria introduces a major secondary pathophysiological driver: chronic psychosocial stress. Prolonged exposure to instability, economic hardship, and displacement drives sustained overactivity of the hypothalamic-pituitary-adrenal (HPA) axis. The resulting continuous, low-grade elevation of circulating cortisol serves as a physiological antagonist to insulin, promotes gluconeogenesis, and preferentially directs lipid deposition into visceral (android) fat depots rather than subcutaneous tissue (Yousuf & Ahmedani 2020). Visceral adiposity and adipokine shifts cause elevated FFAs, TNF-α, and IL-6, causing IRS-1 pathway inhibition and systematic insulin resistance with hyperglycemia. Hepatic insulin resistance enhances de novo lipogenesis and suppresses endothelial LPL, yielding atherogenic hypertriglyceridemia. Hyperinsulinemia and AGE accumulation stimulate SNS/RAAS hyperactivation and reduce eNOS expression, provoking endothelial dysfunction and hypertension. Ultimately, chronic HPA-axis activation drives sustained cortisol release and induces hepatic gluconeogenesis, which accelerates prediabetes progression. Our results align with, and in some instances diverge from, regional and international epidemiological literature. The profound rates of metabolic clustering and the strong link between dysglycemia and hypertriglyceridemia are robustly supported by regional literature. Studies from conflict-affected settings in the Middle East confirm that forced nutritional transitions, characterized by a reliance on subsidized, energy-dense, shelf-stable carbohydrates and trans-fats at the expense of fresh produce, rapidly induce a pattern of diabetic dyslipidemia (Akik et al. 2020). Our findings regarding age-related metabolic decay, where advancing age significantly correlated with waist circumference, MAP, and fasting glucose, are entirely consistent with standard medical literature showing progressive vascular remodeling, arterial stiffening, and a natural decline in insulin sensitivity with age (Cheng et al. 2022). Furthermore, the powerful association between positive family history and current diabetic status (72.7% vs 40.2%) mirrors extensive global data validating the high heritability and shared domestic environmental risks of type 2 diabetes (American Diabetes Association 2024). Conversely, two key outcomes in our study contrast sharply with broader international trends, starting with the gender disparity paradox. In our cohort, females displayed significantly higher rates of diabetes (28.1% vs. 11.8%), clinical obesity (45.1% vs. 25.9%), and central obesity (63.4% vs. 36.5%) compared to males. Globally, males frequently display higher or equal rates of type 2 diabetes at lower BMI thresholds due to differences in intrinsic liver fat accumulation (Kautzky-Willer et al. 2016). However, our data is strongly supported by sub-regional Middle Eastern studies (Aljefree & Ahmed 2015; Ataey et al. 2020), which show that cultural restrictions on outdoor physical movement, high post-pregnancy weight retention, and postmenopausal estrogen decline collectively create an exceptionally high-risk environment for metabolic disease among Middle Eastern women. The second area of divergence relates to non-significant lifestyle variables. Perhaps the most unexpected finding was that lifestyle variables, such as self-reported physical inactivity, dietary habits, and smoking, did not demonstrate a statistically significant standalone association with blood glucose levels. This directly contradicts decades of landmark global trial evidence establishing sedentary behavior and poor diet as foundational causes of dysglycemia. This contradiction does not indicate that lifestyle is irrelevant in North and East Syria. Rather, it highlights a state of diagnostic homogeneity. Because the ongoing crisis has forced nearly the entire local population into uniform dietary constraints (limited access to variety, reliance on identical subsidized grains) and shared limitations on active recreation, there is insufficient behavioral variance within the cohort for standard Chi-square tests to detect a statistical difference. This indicates that the entire region is exposed to a baseline environmental risk, masking individual behavioral correlations (Auad et al. 2022). The extensive overlap of visceral obesity, hypertension, hypertriglyceridemia, and glucose intolerance highlights an urgent public health crisis. In resource-constrained and conflict-affected zones, managing advanced, long-term complications of untreated diabetes, such as chronic kidney disease, stroke, and cardiovascular events, places an unsustainable financial and operational burden on fragile health infrastructure. Therefore, clinical paradigms in the region must turn from reactive treatments to proactive, low-cost screening. Because overall BMI did not correlate significantly with age, but waist circumference did, clinicians should prioritize measuring waist circumference over absolute body weight to avoid missing cases of sarcopenic or metabolically obese normal weight (MONW) individuals. Given the strong familial aggregation identified, primary care systems should implement targeted, household-level metabolic screenings for families with a known history of diabetes, pairing accessible blood pressure checks with routine capillary blood glucose testing to capture metabolic syndrome in its highly treatable, prediabetic window (Auad et al. 2022; World Health Organization 2023d).

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