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Prevalence of Pre-Diabetes and Its Associated Risk Factors among Medical Students in Jazan University KSA

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Abstract

Objectives: Diabetes is one of the most prevalent diseases in Saudi Arabia. Pre-diabetes is the predisposition to diabetes that is accompanied by metabolic syndrome, which accelerates the process leading to diabetes and causes an increase in complications, so this current study aimed to detect the prevalence of pre-diabetes in apparently medical students in Jazan University, also investigate the clinical conditions accompanying prediabetes and the effect of the association of metabolic syndrome on clinical outcomes in prediabetic. **Subjects and methods**: This cross-sectional study was carried out in the Department of medical laboratory science of Jazan University between February 2025 and April 2025 on male and female students in Jazan University, Jazan city. A hundred apparently healthy medical students between the ages of 18 and 23 were recruited based on defined inclusion and exclusion criteria. A questionnaire form with details of age, weight, height, History of HT, Smoking, Family history of dyslipidemia, family history of diabetes, Physical activity, History of CAD, hormonal disorders, and family history of ASCVD was obtained. Approximately, 5 ml of blood was extracted for the measurement of fasting plasma glucose (FPG), HbA1c, lipid profile and insulin. Comparison between groups was done for statistical significance using an unpaired t-test. Significance was set at $P < 0.05$ for all comparisons. **Results**: In the total study sample of 100 patients, the prevalence of prediabetes was 27% (FPG: 100 - 125 mg/dl,

HbA1c: 5.7 - 6.4%). Among 50 females, 14 females (28%) had prediabetes while 13 males from 50 had prediabetes. Metabolic syndrome (MetS) was present in 16 of 27 prediabetic patients included in the study. Low-density lipoprotein (LDL) elevation, dyslipidemia, and high triglyceride were detected more frequently in prediabetic individuals accompanied by MetS. **Conclusion**: Results of the current study showed a 27% prevalence of pre-diabetes among medical students. Dyslipidemia, and metabolic syndrome coexistence make prediabetic individuals accompanied by MetS at greater risk.

Keywords

Pre-Diabetes, Metabolic Syndrome, Dyslipidemia

1. Introduction and Literature Review

Prediabetes is a critical health stage that precedes the development of type 2 diabetes, representing a transitional state where blood glucose levels are elevated beyond the normal range but do not yet meet the diagnostic threshold for diabetes. This stage is particularly important because it offers a unique opportunity for intervention before irreversible damage occurs. If left unaddressed, individuals with prediabetes are at a significantly higher risk of progressing to type 2 diabetes, along with its associated complications, including cardiovascular disease, nerve damage, kidney failure, and vision problems. Therefore, understanding prediabetes is essential for promoting public health and reducing the global burden of diabetes-related illnesses [1].

Prediabetes occurs when the body becomes resistant to the action of insulin or when the pancreas fails to produce enough insulin to maintain normal blood glucose levels, so insulin resistance, a hallmark of prediabetes, results in glucose accumulating in the bloodstream rather than being absorbed by cells for energy. Several risk factors contribute to the development of prediabetes, including genetic predisposition, sedentary lifestyle, unhealthy dietary patterns high in refined sugars and fats, obesity, and abdominal fat accumulation. Additionally, advancing age, a family history of diabetes, ethnicity (with higher risks among African Americans, Hispanics, Native Americans, and Asian Americans), sleep disorders, and chronic stress are recognized contributors. Because the progression of prediabetes is often silent and asymptomatic, many individuals remain unaware of their condition, making routine health screenings an indispensable strategy for early identification and management [2].

The importance of recognizing and addressing prediabetes lies in its reversibility or at least the ability to significantly delay the onset of type 2 diabetes with timely preventive actions. Evidence-based interventions emphasize lifestyle modifications as the cornerstone of management. These include achieving modest weight loss (5 - 7% of body weight), engaging in regular physical activity (such as brisk walking for 30 minutes a day, five days a week), and adopting a healthy eating plan that emphasizes whole grains, fruits, vegetables, lean proteins, and limits saturated fats and sug-

ars. Early lifestyle intervention has been shown to reduce the risk of developing type 2 diabetes by as much as 58%. Furthermore, preventive efforts not only diminish the likelihood of diabetes but also decrease the risk of associated conditions such as hypertension, dyslipidemia, and atherosclerosis [3].

According to the World Health Organization (WHO), Saudi Arabia has the second-highest rate of diabetes in the Middle East and the seventh-highest globally. Around 7 million Saudis (24%) are diabetic, while almost 3 million have prediabetes. It is estimated that diabetes costs the Saudi government roughly 14% of its total annual health expenditure. Moreover, there has been a significant increase in the prevalence of both conditions over the past 10 years. In fact, that increase is attributed to a variety of factors, including lifestyle changes, delayed diagnosis, a lack of awareness, and high treatment costs. Consequently, there is an increasing concern over the number of subjects with prediabetes who are unaware of their condition, which might eventually progress into irreversible diabetes. Detection and activation of a treatment plan is a fundamental public health strategy to minimize and control diabetes [4].

Although prediabetes is a serious health concern, it conveys a hopeful message: it is a phase where the individual can still regain full metabolic health through proactive changes. A deep understanding of the condition's pathophysiology, risk factors, and prevention strategies empowers individuals to take charge of their health. Health education initiatives, community outreach programs, early screening campaigns, and individualized counseling play vital roles in empowering people to recognize their risks and make informed decisions. Regular monitoring, medical follow-ups, and supportive environments are essential to sustain behavioral changes and achieve long-term success in preventing type 2 diabetes [5].

Recent studies have highlighted that prediabetes is not a benign condition but is associated with the early development of micro vascular and macro vascular complications even before progression to diabetes. Evidence shows that individuals with prediabetes already have a significantly higher risk for cardiovascular disease and chronic kidney disease compared to those with normal glucose levels [6]. Furthermore, international consensus has emphasized the necessity of proactive interventions in the prediabetes stage to delay or prevent full-blown type 2 diabetes and its associated complications, so the growing prevalence of prediabetes globally, particularly in the Middle East, underscores an urgent need for comprehensive national screening and management programs [7].

Prediabetes is diagnosed through several blood tests designed to evaluate glucose metabolism and identify abnormalities before overt diabetes develops:

1) Fasting Blood Sugar (FBS) Test: This test is conducted after 8 hours of overnight fasting. A blood glucose level between 100 - 125 mg/dL is indicative of prediabetes.

2) Oral Glucose Tolerance Test (OGTT): After fasting, the individual consumes a standardized glucose solution, and blood sugar levels are measured two hours later. A reading between 140 - 199 mg/dL signifies prediabetes. This test is particularly useful in identifying impaired glucose tolerance that may not be evident

with fasting measurements alone.

3) Hemoglobin A1C (HbA1c) Test: This blood test provides an average of a person's blood glucose levels over the previous two to three months. An HbA1c range between 5.7% and 6.4% indicates prediabetes. HbA1c testing offers the advantage of not requiring fasting and is useful for screening and diagnosis.

Early and accurate diagnosis is crucial because it enables timely intervention, reducing the risk of progression to diabetes and associated health complications [8].

Most individuals with prediabetes do not experience overt symptoms, which is why the condition often remains undetected for years. However, when symptoms do occur, they may include darkening of the skin (Acanthosis Nigricans), increased thirst or dry mouth, frequent urination, fatigue or persistent tiredness and blurred vision.

Fortunately, prediabetes is often preventable or reversible through comprehensive lifestyle changes, which serve as the foundation for effective management:

1) Maintaining a healthy weight: Even modest weight loss has a profound impact on improving insulin sensitivity.

2) Following a balanced, low-sugar, high-fiber diet: Prioritizing vegetables, fruits, legumes, and whole grains while minimizing processed foods and sugary beverages.

3) Engaging in regular physical activity: At least 150 minutes of moderate-intensity exercise per week, such as brisk walking, cycling, or swimming, improves glucose metabolism and cardiovascular health.

4) Reducing stress: Practices like mindfulness, meditation, yoga, and adequate sleep are beneficial in lowering stress-induced insulin resistance.

5) Avoiding smoking and limiting alcohol consumption: Both smoking and excessive alcohol intake are associated with an increased risk of insulin resistance and metabolic syndrome.

6) Routine health monitoring: Individuals at high risk should have regular checkups to monitor blood glucose levels and overall metabolic health, allowing for early intervention when necessary.

Adopting these preventive strategies can dramatically reduce the risk of developing type 2 diabetes and promote long-term health and wellbeing.

2. Materials and Methods

2.1. Study Area/Setting

This cross-sectional study was conducted in Jazan region/KSA.

2.2. Study Subjects

The study population consisted of healthy adult medical students over the age of 18 years old.

2.3. Inclusion Criteria

Students must be over the age of 18, Saudi students who are apparently healthy,

feeling well not have chronic disease or take any medication.

2.4. Exclusion Criteria

The students who reported a diagnosed diabetes mellitus and were on insulin therapy, pregnant female students and students who refused to consent.

2.5. Study Design

This cross-sectional study was carried out in the Department of medical laboratory science of Jazan University between February 2025 and April 2025 on male and female students in Jazan University, Jazan city.

2.6. Sample Size

Hundred apparently healthy medical students between the age group of 18 - 23 years were recruited based on defined inclusion and exclusion criteria.

2.7. Data Collection Methods

2.7.1. Sampling Technique

The questionnaire was designed to collect data, including demographic information, lifestyle factors, medical history, anthropometric measurements, and laboratory test results.

Demographic variables included age, sex, and educational level. Lifestyle and medical factors included smoking status, history of hypertension, and family history of diabetes mellitus.

Participants were required to fast overnight for 8 to 10 hours before sample collection. Five milliliters of venous blood were collected into plain, fluoride oxalate, and EDTA containers to measure fasting plasma glucose (FPG), HbA1c, lipid profile, and insulin levels.

After collection, blood samples were centrifuged at appropriate speeds to separate the plasma. The obtained plasma was carefully collected and stored at –20˚C in a freezer until further analysis. Subsequently, biochemical tests such as FPG and HbA1c were performed on the stored plasma samples to assess glucose metabolism status.

2.7.2. Method, Instrument and Reagents

All chemical parameters were measured spectrophotometrically using the Human kit and the Micro Lab 300 spectrophotometer in the chemistry laboratory (Lab G239).

The samples were processed and analyzed fasting insulin by chemilumiscence immunoassay (Cobas, Human company), HbA1c (ion exchange chromatography, commercial kit, Human company, Germany), cholesterol (molybdenum method, commercial kit, Human, Germany), triglyceride (BCG method, commercial kit, Human, Germany) HDL (p-Nitrophenyl phosphate commercial kit, Human, Germany), fasting plasma glucose (GOD/PAP method, commercial kit, Human, Germany) and LDL was calculated by Freidewald equation.

2.7.3. Data Management and Analysis Plan

Statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 20, and the data were presented as percentages.

3. Result

- A total of 100 prediabetic patients, 50% female and 50% male were included in the study. The mean age was 21.6 years (SD ± 9.2). The prevalence of pre-diabetes in females was 14 (28%) and in males was 13 (26%) (Table 1 and Table 2).
- Prediabetes was accompanied by MetS in 8 (61.5%) of the male and 8 (57.1%) of the female (Table 3).
- Obesity and overweight are higher in females than males (Table 4).
- Table 4 illustrates the prevalence of demographic and lifestyle covariates associated with participants where a history of hypertension, diabetes mellitus, CAD and dyslipidemia were compared according to sex.

Table 1. Prevalence of diabetes and prediabetes among the participants by measuring either HbA1c or FBG.

Variable		Female (N, %) 50 females	Male (N, %) 50 males	Total (N, %) 100 participants
FPG (mg/dl)				
Normal	70 - 100	36 (72%)	37 (74%)	73 (73%)
Prediabetes	100 - 125	14 (28%)	13 (26%)	27 (27%)
Diabetes	≥125	0 (0%)	0 (0%)	0 (%)
HbA1c (%)				
Normal	<5.7	39 (78%)	40 (80%)	79 (79%)
Prediabetes	5.7 - 6.4	11 (22%)	10 (20%)	21 (21%)
Diabetes	≥6.5	0 (0%)	0 (0%)	0 (%)

Table 2. Prevalence of diabetes among participant by measuring FPG and HbA1c: ADA criteria.

Variable	Male (50)	Female (50)	Total (100)
Prediabetes	13(26%)	14 (28%)	27 (27%)

Table 3. Metabolic syndrome among prediabetes.

Variable	Male (13)	Female (14)	p. Value
Have MetS	8 (61.5%)	8 (57.1%)	**0.19**
Have not MetS	5 (38.5%)	6(42.9%)	

Table 4. Baseline characteristics of study populations by gender.

Variables	Male: n, %	Female: n, %
BMI (kg/m^2)		32 (64%)
Normal < 25	35 (70%)	9 (18%)

Continued

Overweight = 25 - 29.9	7 (14%)	9 (18%)
Obese ≥ 30	8 (16%)	32 (64%)
History of HT		
Yes	11 (22%)	12 (24%)
No	39 (78%)	38 (76%)
History of dyslipidemia		
Yes	3 (6%)	5 (10%)
No	47 (94%)	45 (90%)
History of CAD		
Yes	4 (8%)	2 (4%)
No	46 (92%)	48 (94%)
History of DM		
Yes	13 (26%)	10 (20%)
No	37 (74%)	40 (80%)

4. Discussion

The present study revealed a notable prevalence of prediabetes among medical students at Jazan University, with an overall rate of 27%. This finding is consistent with the data reported by the National Survey of Health Information of Saudi Arabia, suggesting that prediabetes is increasingly prevalent among young adults in the region. The relatively high percentage observed in this specific population highlights a growing public health concern, particularly given the participants' young age group (18 - 23 years).

Obesity, sedentary lifestyle, poor dietary habits, and a strong family history of diabetes are known risk factors that significantly contribute to the development of prediabetes, all of which were evident among the study population. Female students showed a slightly higher prevalence (28%) compared to males (26%), indicating that gender differences may play a role, possibly due to variations in physical activity levels, body composition, and hormonal influences.

An important observation in this study is the association between prediabetes and metabolic syndrome (MetS). Among prediabetic individuals, approximately 59% were also diagnosed with MetS, with higher LDL cholesterol levels, dyslipidemia, and elevated triglycerides being significantly more frequent among them. The coexistence of MetS further exacerbates the risk of developing type 2 diabetes and cardiovascular diseases, emphasizing the need for early identification and intervention in at-risk individuals.

Our study employed both fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c) for the diagnosis of prediabetes. Interestingly, the prevalence detected using FPG criteria was slightly higher than that identified through HbA1c testing. This discrepancy suggests that relying solely on FPG or HbA1c may lead

to underestimation or overestimation of true prevalence rates, underlining the importance of using a combined diagnostic approach for a more accurate assessment, as recommended by the American Diabetes Association (ADA).

Similar studies in the literature have shown variations in prediabetes prevalence depending on the diagnostic methods used. Some studies relying exclusively on FPG have reported lower prevalence rates compared to those incorporating HbA1c. Our findings, therefore, support the need for comprehensive screening strategies that utilize both markers, especially in younger populations who may not exhibit classic risk profiles.

Moreover, the significant percentage of participants who were overweight or obese, particularly among female students, is a major concern. With 36% of females falling into the overweight or obese category, targeted preventive interventions focusing on weight management, physical activity promotion, and healthy eating are urgently needed within university settings.

In light of these findings, it is imperative to implement public health strategies tailored toward early screening, health education, and lifestyle modification among young adults. University-based wellness programs that encourage regular physical activity, stress management, balanced nutrition, and routine medical checkups could serve as effective tools to curb the rising incidence of prediabetes and its progression to type 2 diabetes.

Overall, this study contributes valuable insights into the prevalence and risk factors of prediabetes among medical students and underscores the critical role of early prevention in minimizing future disease burden.

5. Conclusions

The findings of this study revealed a significant prevalence of prediabetes (27%) among medical students at Jazan University, with a slightly higher rate among females compared to males. The association between prediabetes and metabolic syndrome was notably high, highlighting the increased risk for future development of type 2 diabetes and cardiovascular complications. These results emphasize the importance of early detection, particularly through the combined use of fasting plasma glucose and HbA1c measurements, to ensure a more accurate diagnosis.

Furthermore, the strong correlation between obesity, dyslipidemia, and prediabetes among the participants stresses the urgent need for preventive strategies targeting modifiable risk factors. Early intervention through lifestyle modifications can substantially reduce the incidence of diabetes and improve the overall health of young adults.

Based on the results of this study, the following recommendations are proposed:

1) Implement regular screening programs for prediabetes and metabolic syndrome among university students, particularly those with risk factors such as family history or obesity.

2) Develop health promotion campaigns focusing on the importance of healthy

eating habits, increased physical activity, and weight management within university environments.

3) Encourage the incorporation of educational modules on diabetes prevention and healthy lifestyle practices into the university curriculum.

4) Establish wellness centers or clinics within universities to provide continuous health monitoring, counseling, and support services for students.

5) Conduct further longitudinal studies to monitor the progression of prediabetes and evaluate the effectiveness of implemented preventive interventions over time.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Questionnaire

Name
Gender
Age (year)
Level of education (third - eight)
Weight (kg)
Height (cm)
BMI (kg/m2)
SBP (mmHg)
DBP (mmHg)
Blood pressure (mmHg)
History of HT
Smoking status
Never
Former
Current
Has a family history of dyslipidemia
Has a family history of diabetes
Physical activity
History of CAD
Has any hormonal disorders
Has a family history of (ASCVD)= Atherosclerotic cardiovascular disease