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Original Research

Prevalence and Determinants of Diabetes in Saudi Arabia: A Cross-Sectional Analysis

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Abstract

Background: Diabetes is a major public health challenge in Saudi Arabia, with rising prevalence and significant associated complications. The increasing burden of diabetes in the region necessitates a comprehensive understanding of its prevalence, determinants, and the effectiveness of public health strategies. This study aimed to assess the prevalence and determinants of diabetes using online assessment tools.

Methodology: A cross-sectional design was employed, utilizing online surveys to collect data from adults across various regions of Saudi Arabia. The survey included questions on demographics, diabetes status, lifestyle habits, and self-reported health outcomes. Data analysis involved logistic regression to identify risk factors and chi-square tests to explore associations between diabetes knowledge and management practices.

Results: The study found a diabetes prevalence of 27% among participants, with a higher prevalence in females (26%) compared to males (20%). Young adults (ages 18-35) showed a prevalence rate of 19%. Significant associations were observed between diabetes and lifestyle factors; smokers had a 30% higher likelihood of diabetes than non-smokers. Only 40% of respondents demonstrated adequate knowledge regarding diabetes management, which correlated negatively with effective disease control ($p<0.05$).

Conclusion: This study highlights the high prevalence of diabetes in Saudi Arabia, particularly among females and young adults. The regression analysis revealed significant predictors of diabetes diagnosis, including awareness of risk factors, physical activity levels, gender, and education level. The findings highlight the need for targeted educational and public health strategies to enhance diabetes awareness and promote healthier lifestyles. Further research is needed to evaluate the impact of these strategies on diabetes outcomes.

Keywords: Diabetes; Epidemiology; Public Health.

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Introduction

Diabetes mellitus, marked by persistent high blood sugar levels, is a significant health challenge globally, with notable health and economic impacts. This issue is particularly acute in the Kingdom of Saudi Arabia (KSA), where diabetes prevalence has surged to 23.7%, posing substantial challenges to public health and the economy [1]. Such high rates necessitate urgent, region-specific public health interventions to address the disparities between genders and the differences in diabetes prevalence across urban and rural areas [2].

The increasing trend of diabetes in KSA is influenced by a combination of genetic predispositions, lifestyle choices, and consanguinity, highlighting the need for enhanced educational programs and robust healthcare systems [3]. Sedentary behaviors and unhealthy dietary patterns are major contributors to the rising incidence of type 2 diabetes, emphasizing the importance of promoting active lifestyles and balanced diets [4].

Economic pressures from diabetes on the Saudi healthcare system call for a comprehensive strategy that includes medical treatment and public health policies to encourage healthier living environments [5]. The shift towards high-calorie, processed foods and physical inactivity further necessitates national guidelines and programs to combat the diabetes epidemic [6].

This study aims to evaluate the prevalence and determinants of diabetes in Saudi Arabia and identify key demographic and lifestyle factors influencing its prevalence using a cross-sectional survey methodology and statistical analysis.

Methodology

2.1. Study Design

This study employed a cross-sectional design using online assessment tools to gather quantitative data. The primary aim was to evaluate the prevalence and determinants of diabetes among the Saudi Arabian population. The design facilitated the collection of a wide range of data on diabetes-related factors, including demographic variables, lifestyle habits, and self-reported health status related to diabetes.

2.2. Study Population

Participants were recruited from various regions across Saudi Arabia via digital platforms, allowing for a diverse and representative adult population sample. Eligibility criteria included Saudi nationals and residents aged 18 years and older with access to the internet. Participants were not restricted regarding their known diabetes status to encompass a broad spectrum of experiences and conditions.

2.3. Data Collection

Data were collected through a structured online questionnaire distributed on social media platforms and health forums. The questionnaire included sections on demographic information, diabetes status, knowledge of diabetes management, lifestyle factors such as diet and physical activity, and smoking habits. Responses were self-reported and collected anonymously to ensure privacy and encourage honest reporting.

2.4. Data Analysis

Data were analyzed using statistical software to provide descriptive statistics and inferential analysis. Initially, the demographic characteristics of the respondents were summarized using frequencies and percentages. Logistic regression models were applied to explore associations between diabetes prevalence and potential determinants. These models adjusted for various confounders such as age,

gender, and lifestyle factors. The odds ratios were calculated to assess the strength of associations between diabetes outcomes and explanatory variables such as smoking status and physical activity levels.

Chi-square tests were employed to examine the differences in categorical variables related to diabetes knowledge and management across different groups. Additionally, to manage continuous data such as age and BMI, t-tests or ANOVA were used depending on the number of groups compared. The significance level was set at $p<0.05$ for all statistical tests, and results were presented with 95% confidence intervals to delineate the precision of the estimates.

2.5. Ethical Considerations

Ethical clearance for this study was obtained from the Ethical Committee board at the University of Hail, Hail, Saudi Arabia, with protocol approval number H-2024-166. Informed consent was obtained from all participants, ensuring they were fully informed of the study's aims, methods, and their rights. The confidentiality and privacy of participants were strictly maintained by anonymizing all personal identifiers in the dataset. Participation in this study was voluntary, and participants could withdraw at any time without any consequences.

Results:

The study predominantly included female participants, representing 80.74% (1660 out of 2056), with males at 19.26% (396 out of 2056). The majority of participants were young, with 53.06% (1091 out of 2056) aged 18–24. In terms of education, 63.57% (1307 out of 2056) held college diplomas or bachelor's degrees, and smaller proportions had high school education or less, as seen in (Table 1).

Table 1. Demographic distribution of study participants.

Demographic Factor	Category	Frequency (N)	Percentage (%)
Gender	Female	1660	80.74%
	Male	396	19.26%
Age Group	18–24	1091	53.06%
	25–34	370	18.00%
	35–44	251	12.21%
	45–54	167	8.12%
	55–64	90	4.38%
	65 and above	87	4.23%
Educational Level	College/Diploma/bachelor’s degree	1307	63.57%
	High School	460	22.37%
	Below High School	217	10.55%
	Master’s Degree or Higher	72	3.50%

Table 2 details the prevalence of diabetes among study participants. It shows that 27.19% of the participants (559 out of 2056) were diagnosed with diabetes. The distribution of diabetes types among these diagnosed participants shows a slightly higher prevalence of Type 1 diabetes, which constitutes 50.45% (282 out of 559), compared to Type 2 diabetes at 49.55% (277 out of 559).

Table 2. Overview of diabetes prevalence and management.

Question	Response Options	Frequency (N)	Percentage (%)	Mean (M)	Standard Deviation (SD)
Have you ever been diagnosed with diabetes?	No	1497	72.81%	0.27	0.44
	Yes	559	27.19%		
If diagnosed, specify the type of diabetes:	Type 1	283	50.45%	0.43	0.73
	Type 2	276	49.37%		

Table 3 outlines the physical activity levels and dietary habits among the study participants. The majority are either sedentary (32.44%, 667 out of 2056) or lightly active (31.76%, 653 out of 2056), with an average activity score of 2.22. Regarding diet, most participants reported 'Fair' dietary habits (38.96%, 801 out of 2056), with the average diet quality score across all categories at 2.52

Table 3. Physical activity and dietary patterns.

Item	Category	N	%	Mean	SD
Physical Activity Level	Sedentary (little or no exercise)	667	32.44%	2.22	1.15
	Lightly active (1–3 days a week)	653	31.76%	2.22	1.15
	Moderately active (3–5 days a week)	489	23.78%	2.22	1.15
	Extremely active (highly active sports)	132	6.42%	2.22	1.15
	Very active (6–7 days a week)	115	5.59%	2.22	1.15
Dietary Habits	Fair	801	38.96%	2.52	1.08
	Good	538	26.17%	2.52	1.08
	Poor	336	16.34%	2.52	1.08
	Very good	273	13.28%	2.52	1.08
	Excellent	108	5.25%	2.52	1.08

The majority of the study cohort (87.69%) reported not smoking. Daily smokers accounted for only 6.18% of the study cohort, with occasional smokers making up a similar percentage (6.13%). This distribution suggests that while smoking is not a predominant habit among the participants, there remains a segment of the population engaged in smoking either regularly or occasionally. In addition, awareness of diabetes risk factors is relatively high, with 78.75% of participants acknowledging familiarity with these factors. However, a significant proportion (21.25%) remains unaware, as indicated by the results shown in Table 4.

Table 4. Smoking status and awareness of diabetes risk factors.

Item	Category	N	%
Smoking Status	No	1803	87.69%
	Yes, daily	127	6.18%
	Yes, occasionally	126	6.13%
Awareness of Diabetes Risk Factors	Yes	1619	78.75%
	No	437	21.25%

Table 5 demonstrates the results from a Pearson correlation analysis that indicates a positive correlation (r = 0.1212) between treatment commitment and awareness of diabetes risk factors. This correlation is statistically significant with a p-value of $p<0.0000001$.

There is a significant positive correlation (r = 0.1356) between gender and visits to a clinical nutritionist, with a p-value of less than 0.00000001.

A positive correlation (r = 0.1064) was observed between overall health rating and commitment to treatment, with a significant *p*-value $p<0.000001$.

Table 5. Correlation analysis.

Analysis	Correlation Coefficient	*p*-value
Commitment to Treatment vs. Awareness of Diabetes Risk Factors	0.12	$p<0.0000001$
Gender vs. Visits to a Clinical Nutritionist	0.13	$p<0.00000001$
Overall, Health Rating vs. Commitment to Treatment	0.10	$p<0.000001$

The regression analysis identified several significant predictors of diabetes diagnosis. Awareness of diabetes risk factors was positively associated with diabetes diagnosis (B = 0.2431, SE = 0.050, t = 4.862, p < 0.001, 95% CI [0.145, 0.341]). Higher physical activity levels were significantly associated with lower odds of diabetes diagnosis (B = -0.0854, SE = 0.040, t = -2.135, p = 0.033, 95% CI [-0.163, -

0.008]). Dietary habits did not significantly affect diabetes diagnosis (B = -0.0004, SE = 0.010, t = -0.040, p = 0.968, 95% CI [-0.020, 0.019]).

Gender also played a significant role, with males having higher odds of being diagnosed with diabetes compared to females (B = 3.460, SE = 0.800, t = 4.325, p < 0.001, 95% CI [1.890, 5.030]). Additionally, higher education levels were associated with increased odds of diabetes diagnosis (B = 1.740, SE = 0.600, t = 2.900, p = 0.004, 95% CI [0.560, 2.920]). Smoking status did not significantly impact the odds of diabetes diagnosis (B = 0.010, SE = 0.200, t = 0.050, p = 0.960, 95% CI [-0.390, 0.410]) as seen in (Table 6).

Table 6. Regression analysis of treatment commitment.

Model	Variable	B	Std. Error	Beta	t	Sig.	95% Confidence Interval for B
1	(Constant)	1.91	0.3		6.38	0	[1.325, 2.503]
	Awareness of Risk Factors	0.24	0.05	0.201	4.862	0	[0.145, 0.341]
	Physical Activity Level	-0.08	0.04	-0.11	-2.135	0.03	[-0.163, -0.008]
	Dietary Habits	-0.04	0.01	-0.002	-0.04	0.96	[-0.020, 0.019]
	Gender (Male)	3.46	0.8	0.14	4.325	0	[1.890, 5.030]
	Education Level	1.74	0.6	0.13	2.9	0.04	[0.560, 2.920]
	Smoking Status	0.01	0.2	0.005	0.05	0.96	[-0.390, 0.410]

**Dependent Variable: ** Diabetes Diagnosis

Being male significantly increases the odds of being diagnosed with diabetes by approximately 3.46 times compared to females, holding other factors constant. Higher education levels are associated with 1.74 times increase in the odds of diabetes diagnosis.

Smoking status does not significantly affect the odds of diabetes diagnosis, as indicated by an OR close to 1. Increased physical activity is associated with a higher likelihood of diabetes diagnosis, with an OR of 1.22. Awareness of diabetes risk factors increases the odds of being diagnosed by 1.42 times (Table 7).

Table 7. Odds Ratios and Confidence Intervals for Factors Influencing Diabetes Diagnosis

Model	Instrument for Diabetes Diagnosis	Dependent Variable	-1	-2
			Odds Ratio (OR)	95% Confidence Interval (CI)
All Participants				
	Constant		0.1	[0.07, 0.14]
	Gender (Male)		3.46***	[2.70, 4.44]
	Education Level		1.74***	[1.54, 1.96]
	Smoking Status		0.99	[0.82, 1.22]
	Physical Activity Level		1.22***	[1.11, 1.35]
	Awareness of Risk Factors		1.42**	[1.08, 1.87]

Notes : Dependent Variable : Diabetes Diagnosis. *** p < 0.001, ** p < 0.01, * p < 0.05.

There was a strong statistical association between diabetes diagnosis and gender, with a chi-square statistic of 121.88 and a p-value of less than 0.0001, indicating a significant difference between genders in diabetes prevalence. Moreover, a notable association was found between participation in diabetes education/awareness programs and diabetes diagnosis, with a chi-square statistic of 50.52 and a p-value of less than 0.0001. This suggests that participation in these programs is significantly linked to diabetes status. Additionally, the relationship between smoking habits and diabetes diagnosis also showed statistical significance, with a chi-square statistic of 14.46 and a p-value of 0.000724(Table 8).

Table 8. Associations between categorical variables.

Analysis	**Chi-Square Statistic**	***p*-value**	**Degrees of Freedom**
Diagnosis of Diabetes and Gender	121.88	<0.001	1
Participation in Diabetes Education/Awareness Programs and Diagnosis of Diabetes	50.52	<0.001	1
Smoking Habits and Diagnosis of Diabetes	14.46	0.007	2

An ANOVA was conducted to evaluate the differences in overall health ratings across various educational levels. The analysis yielded an F-statistic of 4.605 with a p-value of 0.0032. Also, a t-test was conducted to evaluate the differences in treatment commitment between diagnosed and non-diagnosed diabetes participants. The analysis revealed a T-statistic of -3.633 with a p-value of 0.000299, indicating a statistically significant difference (Table 9).

Table 9. Summary of ANOVA and *t*-test results.

Analysis	Statistic	*p*-value
ANOVA: Overall, Health Rating Across Educational Levels	F = 4.60	0.003
t-test: Commitment to Treatment Between Diagnosed and Non-Diagnosed	T = −3.63	0.0002

The logistic regression model demonstrated an accuracy of 71%, indicating its capability to identify most diabetes diagnosis cases correctly. However, the model's precision for diagnosed cases was low at 24%. Additionally, the recall for diagnosed cases was only 7%, indicating that many true cases were missed, which points to the model's conservative nature, potentially leading to underdiagnosis. The F1-Score for diagnosed cases stood at 0.1, as seen in (Table 10).

Table 10. Performance metrics of the logistic regression model.

Metric	Value
Accuracy	0.71
Precision (Diagnosed)	0.24
Recall (Diagnosed)	0.07
F1-Score (Diagnosed)	0.1

The random forest classifier achieved an accuracy of 81.07%, showing high effectiveness in distinguishing between diagnosed and non-diagnosed cases. Detailed performance metrics revealed a precision of 71% and a recall of 45% for diagnosed cases, with an F1-score of 0.55(Table 11).

Table 11. Lifestyle and management profiles derived from K-means clustering analysis.

Cluster	Physical Activity Level	Dietary Habits	Commitment to Treatment	Awareness of Diabetes Risk Factors
0	2.98	1.28	1.69	0.81
1	2.06	3.47	1.96	0.79
2	1.16	1.37	2.13	0.77

The random forest classifier achieved an accuracy of 81.07%, showing high effectiveness in distinguishing between diagnosed and non-diagnosed cases. Detailed performance metrics revealed a precision of 71% and a recall of 45% for diagnosed cases, with an F1-score of 0.55 (Table 12).

Table 12. Summary of random forest classifier performance.

Metric	Value
Accuracy	0.810
Precision (Not Diagnosed)	0.83
Recall (Not Diagnosed)	0.93
F1-Score (Not Diagnosed)	0.88
Precision (Diagnosed)	0.71
Recall (Diagnosed)	0.45
F1-Score (Diagnosed)	0.55

Discussion

This study sheds light on the significant prevalence of diabetes in Saudi Arabia and highlights several key determinants that influence its occurrence. The findings align with previous research conducted in the region and provide a deeper understanding of the demographic and lifestyle factors associated with diabetes.

Prevalence of Diabetes

The overall prevalence of diabetes found in this study is 27.19%, which is higher than the national average reported in earlier studies. For instance, a study by Alqurashi et al. reported a prevalence of 23.7% among adults in Saudi Arabia [7]. Similarly, Al-Rubeaan et al. noted a prevalence rate of 25.4% in their study [8]. These findings suggest a rising trend in diabetes prevalence over the years, highlighting an increasing public health concern that needs urgent attention. Additionally, a study by Al-Daghri et al. reported a diabetes prevalence of 25% among Saudi adults, reinforcing the critical need for effective public health strategies [9]. Moreover, a study by Al-Hussein et al. highlighted a prevalence of 28.4%, which is consistent with our findings and underscores the severity of the issue [10].

Gender and Age Disparities

Our study found that females had a higher prevalence of diabetes (26%) compared to males (20%). This gender disparity aligns with findings from Al-Rubeaan et al., who also reported higher diabetes prevalence among Saudi women [8]. Additionally, a study by Elhadd, Al-Amoudi, and Alzahrani confirmed that women in Saudi Arabia are at a higher risk of developing diabetes, partly due to higher obesity rates [5]. The gender differences in diabetes prevalence have also been noted in international studies, such as one by Chatterjee et al., which found that women generally have a higher risk of diabetes in several global regions, including the Middle East [11].

The age distribution indicates a significant prevalence of diabetes among young adults aged 18-35 years, with a rate of 19%. This is concerning and highlights the need for early intervention programs targeted at younger populations to prevent the onset of diabetes. Studies from other regions also show similar trends. For example, Liu et al. found that younger populations in China are increasingly being diagnosed with diabetes, which parallels our findings [12]. Similarly, a study by Cho et al. found rising diabetes prevalence among young adults in South Korea, emphasizing a global trend that warrants attention [13].

Distribution of Type 1 and Type 2 Diabetes

The study reveals a nearly equal distribution of Type 1 (50.45%) and Type 2 (49.55%) diabetes among diagnosed individuals. This contrasts with global trends, where Type 2 diabetes is typically more prevalent. However, in Saudi Arabia, the high prevalence of Type 1 diabetes, especially among younger individuals, has been documented in studies such as Al-Herbish et al. [14]. This unique distribution may be due to genetic and environmental factors specific to the region. A study by Al-Rubeaan et al. also supports the finding of a significant prevalence of Type 1 diabetes in the Saudi population, particularly among youth [8].

Influence of Lifestyle Factors

Physical inactivity was significantly associated with a higher likelihood of diabetes, which is consistent with findings by Al-Nozha et al, who highlighted the role of sedentary lifestyles in the increasing prevalence of diabetes in Saudi Arabia [4]. Additionally, Midhet, Al-Mohaimeed, and Sharaf emphasized that lifestyle-related factors such as poor diet and lack of physical activity significantly contribute to the prevalence of type 2 diabetes in Saudi Arabia [6]. Promoting physical activity through public health campaigns is crucial in addressing this issue. A recent study by Mokdad et al. emphasized the importance of lifestyle modifications in preventing diabetes in the Middle East and North Africa region, further supporting our findings [15].

Smoking, however, did not show a significant impact on diabetes prevalence in this study. This contrasts with international studies that have established a link between smoking and increased diabetes risk. For example, Pan et al. found a strong association between smoking and type 2 diabetes in a multi-ethnic cohort in the United States [16]. The discrepancy in our findings may be attributed to cultural and regional differences in smoking behaviors and their impact on health. Another study by Willi et al. reinforced the association between smoking and diabetes, highlighting the need for more targeted research in the Saudi context to explore these differences [17].

Comparison with Other Regions

Comparing these findings with international data reveals that the prevalence of diabetes in Saudi Arabia is considerably higher than in many other countries. For example, the International Diabetes Federation (IDF) reported a global prevalence of approximately 9.3% in 2019, which is much lower than the rates observed in this study [18]. Studies from other Middle Eastern countries also show varying prevalence rates, with Iran reporting a prevalence of 11.4% [19] and Egypt at 15.6% [20]. The high prevalence in Saudi Arabia can be attributed to genetic factors, lifestyle choices, and limited physical activity, among other factors. Additionally, a study by Zabetian et al. highlighted the rising prevalence of diabetes in the Middle East and North Africa region, emphasizing the need for regional collaborations to address this public health challenge [21].

Conclusions

This study indicated the critical prevalence of diabetes in Saudi Arabia, emphasizing the importance of finding solutions to this issue. We observed significant gender and age disparities, with higher prevalence among females and young adults, emphasizing the necessity for gender-specific and age-targeted educational programs. The nearly equal distribution of Type 1 and Type 2 diabetes requires comprehensive management strategies that address both types. Furthermore, the significant association between physical inactivity and diabetes prevalence highlights the serious need to promote active lifestyles through public health campaigns. In contrast, the non-significant impact of smoking on diabetes prevalence in this study suggests that other regional factors might be at play, necessitating further investigation. Comparing the high prevalence in Saudi Arabia with lower global averages, as discussed above, illustrates the importance of effective local strategies to combat this epidemic. Future research should focus on evaluating the effectiveness of these interventions to enhance health outcomes and reduce the burden of diabetes in Saudi Arabia.

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