

PREVALENCE OF PREDIABETES MELLITUS, DIABETES MELLITUS AND ITS ASSOCIATED RISK FACTORS AMONG EMPLOYEES OF PRIMARY HEALTH CARE CENTERS IN JEDDAH, KINGDOM OF SAUDI ARABIA

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ABSTRACT

Background: Diabetes mellitus is a significant and growing health concern worldwide, including in the Kingdom of Saudi Arabia. It is characterized by chronic hyperglycemia, and its increasing prevalence, coupled with its potential for serious complications, necessitates comprehensive

research and public health initiatives to better understand and manage this condition. In this research, we aimed to determine the rate of pre-diabetes and diabetes among healthcare professionals working at primary health care center in Jeddah, Saudi Arabia, and to evaluate the risk factors that are linked with this condition.

Methods: This study was a retrospective cross-sectional study. The study was conducted within the Primary Health Care Centers in Jeddah, Kingdom of Saudi Arabia. The population of interest consisted of all employees, both healthcare and non-healthcare staff, working in the Primary Health Care Centers in Jeddah, Kingdom of Saudi Arabia. Study instruments involved (1) demographic characteristics, (2) anthropometric measurements, (3) work-related factors and (4) assessment of diabetes status.

Results: The study included 153 participants. Based on fasting blood glucose measurements, 44 participants are prediabetes (28.8%) while 11 participants have diabetes. On the other hand, 98 participants had normal fasting blood glucose (64.1%). Furthermore, based on hemoglobin A1c, 19 participants are prediabetes (12.4%) and 28 participants have diabetes (18.3%) while 106 participants are normal (69.3%). Age group appears to be a significant factor in diabetic status ($p = 0.004$). Participants aged 45-60 years have a notably higher prevalence of diabetes compared to those aged 25-44 years. Another important result pertains to marital status ($p < 0.001$). Single individuals show a significantly lower prevalence of diabetes compared to married, widowed, or divorced individuals. Furthermore, education level also shows a significant association with diabetic status ($p = 0.001$). Participants with postgraduate studies exhibit a lower prevalence of diabetes compared to those with a university education.

Conclusion: This study highlights the prevalence of prediabetes and diabetes among the 153 participants, underscoring the significance of these metabolic conditions in the population. The findings reveal that age group, marital status, and education level are critical factors associated with diabetic status, emphasizing the multifaceted nature of diabetes risk. Specifically, older individuals, married participants, and those with lower educational attainment were more likely to have diabetes. These results underscore the importance of tailored healthcare interventions and public health initiatives to address the varying risk profiles within the population and effectively manage and prevent diabetes.

INTRODUCTION

The prevalence of diabetes mellitus (DM) is rapidly increasing [1]. It's a major contributor to death, hospitalizations, and heart problems [2,3]. Prediabetes is a disease that occurs before diabetes and is characterized by elevated blood glucose levels that fall short of the threshold for diabetes [4,5]. It's often understood as a condition when blood glucose levels are elevated but not yet high enough to be classified as type 2 diabetes [5,6]. Prediabetes is defined by the American Diabetes Association (ADA) as a fasting plasma glucose (FPG) level between 100 and 125 mg/dl or a HbA1c level between 5.7 and 6.4% [4-6]. Although the transition from prediabetes to diabetes may take years, once diabetes has set in, it cannot be reversed [7,8]. Therefore, it is crucial to be aware of the situation and to take prompt action to avoid or at least postpone the beginning of T2D [2].

In the United States, between 5 and 10 percent of those with prediabetes acquire type 2 diabetes annually [9,10]. Untreated prediabetes, according to some research [3,] may lead to full-blown diabetes within five years. The prevalence of prediabetes and diabetes is highest among Asians and Middle Easterners [11]. New research shows that in industrialized nations like the United States and the United Kingdom, almost a third of all individuals have prediabetes [9,10]. almost 86 million American adults aged 20 and above (37% of the population) have prediabetes, and almost 90% of them do not know they have the disease [4,12].

There is substantial evidence between obesity and prediabetes [13,14]. Indeed, there is a robust association between central (visceral) obesity and the onset of T2D [14]. Smoking, a family history of diabetes, high blood pressure, high triglycerides, and low HDL cholesterol are additional risk factors [13,14].

The World Health Organization (WHO) places Saudi Arabia at number two in the Middle East and seventh in the world for the prevalence of diabetes [1]. Seven million (24% of the population) Saudis have diabetes, while another three million have prediabetes [15]. About 14% of Saudi Arabia's yearly health spending is attributed to diabetes [11,15]. Moreover, the incidence of these diseases has skyrocketed in the last decade. Many variables, including modern lifestyles, late diagnosis, a lack of awareness, and prohibitive treatment expenses, are responsible for this rise [9]. Therefore, there is growing anxiety about the amount of people who have prediabetes but don't know it, since this disease may lead to full-blown diabetes if left untreated. One of the most important public health measures that can be taken to reduce and manage diabetes is early diagnosis and implementation of treatment.

Because prediabetes often has no noticeable symptoms, the American Diabetes Association suggests screening only people who have certain risk factors [6]. Screening for prediabetes is recommended for those with a body mass index (BMI) of 25 Kg/m² or above and other risk factors. Screening should begin no later than age 45 in the absence of risk factors. Validated assays for prediabetes diagnosis include fasting plasma glucose (FPG), two-hour plasma glucose (2h PG) following a 75g oral glucose tolerance test, and hemoglobin A1c [13]. Intense lifestyle adaption, such as weight reduction, physical exercise, and a balanced diet, is the most effective intervention option for prediabetes, as stated by the ADA. Although less effective than rigorous lifestyle modification, drug-based intervention may potentially be considered to minimize the risk of progression to T2D [6]. Metformin, when used in combination with significant changes in lifestyle, has been shown to reduce the risk of development to diabetes. In a randomized controlled study, individuals with increased blood glucose who were allocated to a lifestyle modification program had a 58% decrease in the incidence of diabetes, while those assigned to metformin had a 31% reduction compared to those given a placebo [16]. Because of the gravity of the problem, more study is needed to examine diabetes and pre-diabetes in Saudi Arabia from every angle.

In this research, we aimed to determine the rate of pre-diabetes and diabetes among healthcare professionals working at primary health care center in Jeddah, Saudi Arabia, and to evaluate the risk factors that are linked with this condition.

METHODS

Study Design

This retrospective cross-sectional study was conducted to assess the prevalence of prediabetes mellitus and diabetes mellitus among employees working at Primary Health Care Centers in Jeddah, Kingdom of Saudi Arabia. Data were collected from the health records of the employees over a specified period.

Study Setting

The study was conducted within the Primary Health Care Centers in Jeddah, Kingdom of Saudi Arabia. These centers were chosen due to their accessibility and the availability of comprehensive health records for employees.

Population

The population of interest consisted of all employees, both healthcare and non-healthcare staff, working in the Primary Health Care Centers in Jeddah, Kingdom of Saudi Arabia.

Sample and Sampling

A systematic random sampling method was employed to select a representative sample of employees from the population. The sampling frame included all employees in the health centers. A random start point was chosen, and every *n*th employee was selected to be part of the sample, ensuring a diverse representation.

Data Collection

Data were collected from electronic health records and relevant administrative databases of the Primary Health Care Centers. Information on demographic characteristics, medical history, laboratory test results, and risk factors for diabetes mellitus and prediabetes mellitus were extracted.

Instruments

The following instruments and tools were used for data collection:

- Health record review forms: A standardized form was developed to extract relevant information from the electronic health records.
- Laboratory records: Fasting blood glucose levels, HbA1c levels, and lipid profiles were recorded from laboratory reports.
- Questionnaires: A structured questionnaire was used to gather information on risk factors, lifestyle, and family history of diabetes mellitus.

Data Analysis

Data were analyzed using statistical software (SPSS). Descriptive statistics were used to summarize the characteristics of the study population, and prevalence rates of prediabetes mellitus and diabetes mellitus were calculated. Bivariate and multivariate analyses, including logistic regression, were conducted to assess the associations between risk factors and the prevalence of prediabetes mellitus and diabetes mellitus.

Ethical Consideration

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of [Institution Name]. Informed consent was not required since the study used retrospective data from health records. All data were anonymized and stored securely to ensure the confidentiality and privacy of the participants.

RESULTS

The study included 153 participants. The mean age was 37.27 ± 8.51 years with median age of 36 years. More than two thirds of study participants were female (n= 106, 69.3%). In addition, more than two thirds were married (n= 108, 70.6%). More than half of study participants are holding postgraduate studies (n= 94, 61.4%). Moreover, more than half of participants are nonsmokers (n= 93, 60.8%). Table 1 summarizes demographic characteristics of study participants. More than half of participants had good monthly income (n= 91, 59.5%). Half of participants had an experience years of either less than five years (n= 40, 26.1%) or 11-15 years (n= 40, 26.1%). Participants were from different professions such as general practitioner, consultant, specialist doctors, dentist, nurse and administrators. Table 1 summarizes participants' characteristics.

Table 1: Demographic and work-related characteristics			
Variable		Frequency	Percent
Gender	Male	47	30.7
	Female	106	69.3
Age group	25-44	124	81
	45-60	29	19
Marital status	Single	30	19.6
	Married	108	70.6
	Widowed	3	2

	Divorced	12	7.8
Education	University	59	38.6
	Postgraduate studies	94	61.4
Monthly income	Low	12	7.8
	Good	91	59.5
	Excellent	50	32.7
Experience	1-5 years	40	26.1
	6-10 years	38	24.8
	11-15 years	40	26.1
	More than 15 years	35	22.9
Smoking status	Never smoked	93	60.8
	Ex-smoker	25	16.3
	Smoker	35	22.9

The mean weight among study participants was 73.9 ± 20.48 kg with median weight of 68 kg. Weight ranged from 45 to 178 kg. The mean height among study participants was 1.61 ± 0.14 meter with median height of 1.6 meter. Height ranged from 0.9 to 1.89 meter. The mean body mass index among study participants was 30.06 ± 5.2 kg/m² with median BMI of 25 kg/m². BMI ranged from 17.76 to 52.35 kg/m². The mean waist circumference among study participants was 73.43 ± 16.2 cm with median waist circumference of 80 cm. Waist circumference ranged from 44 to 160 cm. Since anthropometric measurements are not normally distributed among study participants, we compared the median values to examine the statistical significance between male and female participants. It was found that median values are significantly different between male and female participants as presented in table 2. Most of study participants were categorized in normal (n= 56, 36.6%) or overweight (n= 50, 32.7%) categories of body mass index (figure 1).

<i>Table 2: Non-parametric test evaluation of median difference among study participants</i>			
Anthropometric measure	Male	Female	P value
Weight (kg)	90	65	<0.001
Height (cm)	171	158	<0.001
Waist circumference (cm)	85	80	0.037

Body mass index (kg/m ²)	29.98	25.75	0.012
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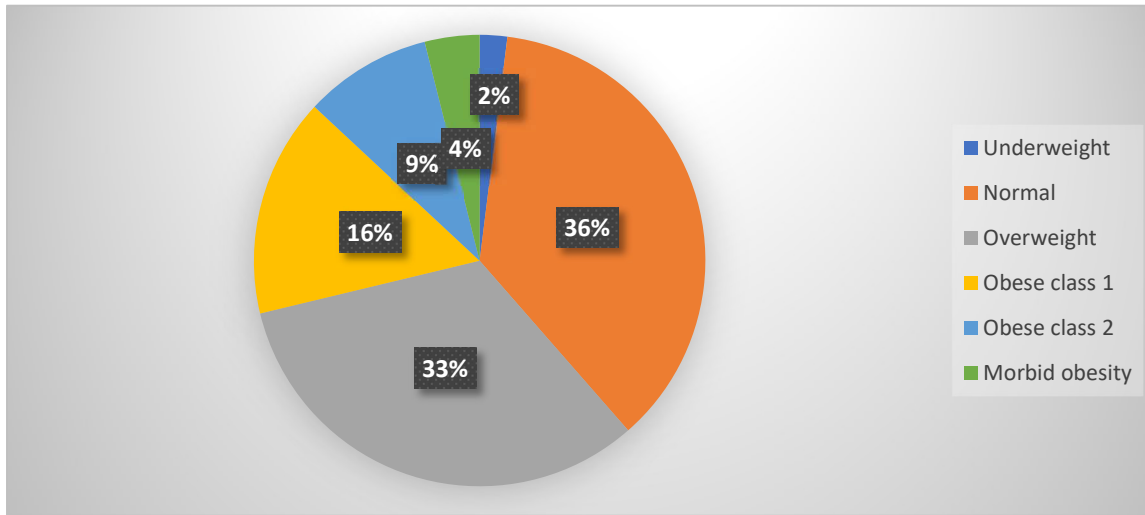


Figure 1: Distribution of study participants according to their body mass index

Based on fasting blood glucose measurements, 44 participants are prediabetes (28.8%) while 11 participants have diabetes. On the other hand, 98 participants had normal fasting blood glucose (64.1%). Furthermore, based on hemoglobin A1c, 19 participants are prediabetes (12.4%) and 28 participants have diabetes (18.3%) while 106 participants are normal (69.3%) (Table 3). More than two thirds of study participants had family history of diabetes (n= 111, 72.5%) and hypertension (n= 104, 68%).

Fasting blood glucose / HbA1c		Fasting blood glucose			P value
		Normal	Prediabetes	Diabetes	
HbA1c	Normal	82	23	1	<0.001
	Prediabetes	1	18	0	
	Diabetes	15	3	10	

There were 30 participants on healthy diet and the same on unhealthy diet (n= 30, 19.6%) while the rest are intermediate (n= 93, 60.8%). Most of study participants perform exercise on a daily or weekly basis. However, 25 participants were found not to be performing any exercise (16.3%).

Table 4 consolidates data from multiple factors affecting work conditions, including Work Stress, Break Duration, Comfort, Hours per Week, Night Shifts, Night Shifts per Month, Satisfaction with Income, and Income Workload. Each factor has its own set of categories, and the table provides frequencies, percentages, valid percentages, and cumulative percentages for each category within these factors. The data represents responses from a sample of 153 individuals, and it sheds light

on various aspects of their work conditions. For instance, it shows that the majority of respondents experience work stress “Sometimes” (39.9%), find their work “Usually” comfortable (29.4%), and work for “26-40 hours” per week (56.2%). Additionally, it provides insights into factors like night shifts and income satisfaction, which can be valuable for understanding the work-related experiences of the surveyed individuals. This consolidated table allows for a quick overview of the responses across multiple dimensions of work conditions.

<i>Table 4: Participants’ perception toward work related factors</i>		
Factor	Frequency	Percent
Work Stress		
Always	39	25.5
Never	2	1.3
Rarely	6	3.9
Sometimes	61	39.9
Usually	45	29.4
Break Duration		
0-5 minutes	13	8.5
16-30 minutes	71	46.4
6-15 minutes	35	22.9
More than 30 minutes	34	22.2
Comfortable at work		
No	20	13.1
Sometimes	72	47.1
Yes	61	39.9
Hours per Week		
11-25 hours	9	5.9
26-40 hours	86	56.2
Less than 10 hours	9	5.9

More than 40 hours	49	32.0
Night Shifts		
No	133	86.9
Yes	20	13.1
Night Shifts per Month		
0-3	134	87.6
4-8	12	7.8
More than 8	7	4.6
Satisfaction with Income		
No	40	26.1
Not sure	35	22.9
Yes	78	51.0
Income is suitable workload		
No	69	45.1
Not sure	34	22.2
Yes	50	32.7

Table 5 presents the relationship between participants' characteristics and their diabetic status. Several key findings stand out from this table. Firstly, age group appears to be a significant factor in diabetic status ($p = 0.004$). Participants aged 45-60 years have a notably higher prevalence of diabetes compared to those aged 25-44 years. This suggests that older age is associated with a higher risk of diabetes among the surveyed individuals.

Another important result pertains to marital status ($p < 0.001$). Single individuals show a significantly lower prevalence of diabetes compared to married, widowed, or divorced individuals. This indicates that marital status may have an influence on the likelihood of developing diabetes, with singles having a lower risk.

Furthermore, education level also shows a significant association with diabetic status ($p = 0.001$). Participants with postgraduate studies exhibit a lower prevalence of diabetes compared to those with a university education. This finding suggests that higher educational attainment might be a protective factor against diabetes in this population. Overall, the table highlights the significance

of age, marital status, and education in understanding the distribution of diabetic status among the surveyed individuals, which can be valuable for healthcare interventions and policy planning.

Table 5: Relationship between participants' characteristics and diabetic status					
Variable		Normal	Prediabetes	Diabetes	P value
Gender	Male	30	12	5	0.505
	Female	68	32	6	
Age group	25-44	86	33	5	0.004
	45-60	12	11	6	
Marital status	Single	24	6	0	<0.001
	Married	68	31	8	
	Widowed	1	0	2	
	Divorced	4	7	1	
Education	University	31	19	9	0.001
	Postgraduate studies	67	25	2	
Monthly income	Low	5	6	1	0.175
	Good	57	25	9	
	Excellent	36	13	1	
Experience	1-5 years	34	6	0	0.001
	6-10 years	29	8	1	
	11-15 years	18	18	4	
	More than 15 years	17	12	6	
Smoking status	Never smoked	63	25	5	0.707
	Ex-smoker	14	8	3	
	Smoker	21	11	3	

Body mass index	Underweight	1	0	0	0.114
	Normal	43	12	1	
	Overweight	29	18	3	
	Obese class 1	12	7	5	
	Obese class 2	7	5	2	
	Morbid obesity	4	2	0	
Family history of DM	Yes	68	33	10	0.288
	No	30	11	1	
Weight	Median value	66	70	90	0.266
Height		161	160	162	0.820
Waist circumference		25.4	27.61	32.31	0.014
BMI		80	80	89	0.119

DISCUSSION

The majority of persons in our research were normal with 28.8% were prediabetes. Slightly more people were affected by it in this city than in others in Saudi Arabia. The national prevalence rate of 20% was close to the rates reported in the National Survey of Health Information in Saudi Arabia (17% in men and 15.5% in females, respectively) [17-20]. We anticipated this finding since age is the single most important predictor of developing diabetes or pre-diabetes, and our research focused mostly on people in this age range (25–60). We conclude that a public health plan for accurate screening, diagnosis, and treatment of prediabetes in PHCs is urgently needed. Prediabetes is the precursor to diabetes and is characterized by a lack of symptoms but a high risk for progressing to type 2 diabetes. Therefore, it is important to implement the ADA's suggested screening procedures for prompt diagnosis and treatment. Studies that only used fasting blood glucose (FBG) levels to diagnose prediabetes [21,22] may have significantly underestimated the real prevalence rate of the condition. FBG may be underestimating the real prevalence for the cases addressed by FBG measures, since in our research the prevalence discovered by FBG was somewhat greater than (HbA1c).

Prediabetes prevalence rose with age, as indicated by our research ($P= 0.004$). Our results were reinforced by two recent studies in the kingdom [23,24], both of which found that increasing age was a significant factor in the development of diabetes mellitus and pre-diabetes.

Several risk variables have been shown to have a statistically significant relationship with prediabetes using logistic regression analysis. Obesity and pre-diabetes were linked in a way that could be measured statistically. The risk of prediabetes in obese men is double that in normal-weight men, and in obese women it is about four times higher than in normal-weight women. The risk of insulin resistance and type 2 diabetes rises in tandem with increasing obesity and body fat [20,25]. Our 28.7% prevalence of obesity (defined as a Body Mass Index (BMI) of 30 kg/m^2) is similar with previous data regarding obesity in Saudi Arabia [26,27], which found 36% prevalence in men and 42% prevalence in females. Programs aimed at preventing disease should pay attention to this modifiable risk factor.

When looking at waist circumference as a measure of abdominal obesity, a correlation between a high-risk level 2 in men and a high-risk level 2 in females was shown to be statistically significant. While waist circumference is highly related with prediabetes, it is not assessed in regular clinical examination in PHCs. Rapid lifestyle changes in Saudi Arabia have important consequences for public health. In fact, these alterations to one's way of life are blamed for the proliferation of non-communicable illnesses [28].

Physical inactivity is associated with an increased risk of obesity. These results may be skewed downwards, however, since we only assessed voluntarily active time. Prediabetes was shown to be statistically related with a family history of diabetes, meaning that individuals with an FHDM are more likely to develop the condition than those without. It is widely established that a person's genetic makeup is an immutable risk factor for type 2 diabetes. Two to six times as many individuals with FHDM will acquire type 2 diabetes as would persons without a family history of the disease, according to certain research [29,30]. Taking this into account in public health preventive and control measures is crucial. It has been shown in a few studies [31,32] that lifestyle modification may help lower the risk of developing type 2 diabetes in persons with FHDM, just as it does in those without the condition.

Adults in Saudi Arabia have a high prevalence of hypertension [31]. Subjects with prediabetes and hypertension are more likely to progress to type 2 diabetes than those with prediabetes and normal blood pressure. High blood pressure is linked to metabolic syndrome, which is thought to raise the risk of type 2 diabetes [32]. No connection has been demonstrated in the current research between prediabetes and lifestyle and demographic variables like physical activity and smoking. The study's methodology and the use of a single data point to draw conclusions may be to blame for this discrepancy.

Our research was not without its flaws. We may have limited the applicability of our findings by limiting the sample size to adults who are working at PHCs. Because we did not employ the whole validated Global Physical Activity Questionnaire (GPAQ) to evaluate physical activity, our estimates of individuals' deliberate physical activity may be low.

One of our strongest points was that we evaluated all of the most obvious and widespread risk variables. To the best of our knowledge, this is the first study to evaluate prediabetes among health care professionals working at PHC in Jeddah, a region sorely lacking in epidemiological research. Public health practitioners are strongly encouraged to adopt and execute public health measures for the detection and management of prediabetes. Those at highest risk for developing T2D are the focus of our suggestions for early diagnosis and management. This plan has to pay greater attention

to the growing obese and hypertensive populations. Screening and assessment for prediabetes should be done in those aged 40 and over who have no risk factors. Some indicators, such as body mass index and waist circumference, should be evaluated as part of standard medical checkups. Non-communicable disease preventive strategies should include health education and promotion. The World Health Organization (WHO) identifies obesity as a serious, underreported problem worldwide. It poses a danger to nations all over the globe and may lead to significant health problems including diabetes mellitus. Obesity has reached epidemic proportions in the Gulf nations, necessitating prompt action. Obesity is a complex health issue, thus it will need the combined efforts of all public health organizations to solve the problem. The construction of family jogging tracks, walking places, cycling, walking programs, and school-based physical activities, as well as tight supervision of diet-related variables, are among our proposals. Finally, the various local initiatives, such as health education campaigns and taxes on junk food, that aim to regulate dietary habits should be put into action and assessed.

CONCLUSION

The majority of participants were female and married. Educational attainment was relatively high, with many holding postgraduate degrees. The study included individuals with varying levels of work experience and encompassed a range of professions. A significant portion of participants were nonsmokers. Additionally, participants exhibited a broad spectrum of body mass index (BMI) categories, and most reported a family history of diabetes and hypertension. The analysis of participants' characteristics highlighted some notable patterns. Age group appeared to influence diabetic status, with older participants being more prone to diabetes. Marital status also played a significant role, as single individuals had a lower prevalence of diabetes compared to their married, widowed, or divorced counterparts. Moreover, educational level seemed to be associated with diabetic status, with those holding postgraduate degrees having a lower prevalence of diabetes. The study also explored other health-related factors such as smoking status and found no significant association with diabetic status. Overall, these findings underscore the multifaceted nature of diabetes risk factors and their potential implications for healthcare interventions and public health policies.

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