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Original article

The Prevalence of Prediabetes Phase and Associated Risk Factors in A Sample of the Non-Diabetic Population in Al-Bayda City, Libya: A Cross-Sectional Study

Amal Atair[1]*, Muna Mohamed[1], Nissren Magid[1], Mahmoud Aeteer[2]

[1]Department of Pharmacology, Faculty of Pharmacy, Omar Al-Mukhtar University, Libya
[2] Department of Medicine, AlBida Medical Center, Libya

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Corresponding Email. *Amal.saad@omu.edu.ly*
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ABSTRACT

Aims*: This study was aimed to determine the prevalence of prediabetes in Al-Bayda city and to identify their associated factors.* ***Methods.*** *A cross-sectional study was carried out over a period of 4 months with a sample of 300 participants aged 18-45 years who were asked about weight, height, smoking, lifestyle, family history, current illness, and if they met the inclusion and exclusion criteria. Blood samples were collected from all participants in the study and analyzed for measuring HBA1c.The statistical analysis was performed by using the Statistical Package for social sciences SPSS version 26 (IBM SPSS Statistics-26) by using Regression linear and logistic regression analysis.* ***Results.*** *The prevalence of pre-diabetes in our study was (47.0%). The prevalence of prediabetes during the age group of (30-39) was the higher one, which was (40.3%) and there was a significant association with prediabetes (p=0.031). There was also a significant link between smokers (90 individuals, 30.0%) and prediabetes (p=0.037). When assessing the effect of gender on the risk of prediabetes, we found a significant association between the BMI and female participants (p=0.047). The normal subject will be at risk of developing prediabetes in the prediabetic phase, where is found the association between the age group (40-49 years), BMI, Family history, Neuropathy, Retinopathy and risk of prediabetes.* ***Conclusion.*** *In Al Bayda-Libya, the prevalence of prediabetes is high. this result indicates that Al Bayda will face a high incidence of diabetes soon, which will create a heavy economic burden on healthcare. Age and smoking, especially in men, and BMI in women were the major risk factors. People with normal HbA1C are also at risk of prediabetes who are older, smokers, or have high BMI, positive family history, or have retinopathy or neuropathy complications. Health education should be strengthened to diminish the incidence of new cases of diabetes.*

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INTRODUCTION

Chronic Diabetes Mellitus is a complex disease characterized by multiple complications, which are considered as a direct cause of increasing the rate of morbidity and mortality. Increasing levels of blood glucose, deregulation of protein and lipid, and carbohydrates disorder are characteristics of Diabetes Mellitus disease [1]. It has been reported that either insulin secretion impairment or insulin resistance, or both, are considered predisposing factors for Diabetes Mellitus. A number of vascular complications are linked to chronic diabetes, such as macrovascular complications; cardiovascular diseases and microvascular complications; nephropathy, neuropathy, and retinopathy.

The DM is one of the major community health problems that has become a pandemic worldwide and its occurrence is increasing quickly over the time. According to the World Health Organization (WHO) more than 220 million people in the world have diabetes [2]. In addition, WHO in the latest global evaluation showed that there would be 366 million people with diabetes by the year 2030 [3]. According to WHO, it is estimated that there were 88,000 diabetics patients in Libya the year 2000. This occurrence is estimated to achieve 245,000 diabetics by the year 2030. In Libya, according to local epidemiological studies, the occurrence for known diabetic patients aged over 20 years was 3.8% [4]. As 50% of type 2 diabetic patients are unaware of their diabetes "undiagnosed", the actual prevalence is probably higher.

Type 2 diabetes (T2DM) is the most common form of diabetes, which accounts for 90-95% of those with DM, previously called non-insulin dependent diabetes mellitus (NIDDM) or adult-onset diabetes; T2DM is characterized by insulin resistance with relative insulin deficiency. There are no definite underlying causes of Type 2 diabetes yet, but a combination of unhealthy lifestyle and genetic factors can be considered as a cause of type 2 diabetes. Most patients with type 2 diabetes were obese. Obesity may lead to some degree of insulin resistance and the development of T2DM [1]. Type 2 Diabetes is considered one of the most chronic illnesses nowadays. Type 2 diabetes is typically a gradually progressive disease, and long-standing uncontrolled disease can lead to serious complications such as retinopathy, nephropathy and neuropathy. According to the ADA, the prediabetes phase is defined as any subject having a blood glucose concentration that is higher than normal but not elevated enough to be classified as type2 diabetes. People with prediabetes have a greater possibility of developing type2 diabetes. Prediabetes refers to the condition where blood glucose isn't as high as in diabetes but is higher than the normal level. Patients with prediabetes are defined by the presence of Impaired fasting glucose (IFG) and/or Impaired Glucose Tolerance (IGT) and/or A1C. IFG is defined as Fasting plasma Glucose (FPG) levels between 100 and 125 mg/dL (between 5.6 and 6.9 mmol/L) and (IGT) as 2-h Plasma Glucose during 75-g Oral Glucose Tolerance Test (OGTT) levels between 140 and 199 mg/dL (between 7.8 and 11.0 mmol/L [1].

There is a strong and continuous association between A1C and subsequent diabetes, which is demonstrated by a number of prospective studies that have used A1C to predict the development of diabetes. It is reasonable to consider an A1C range of 5.7–6.4% (39–47 mmol/mol) as a known individual with prediabetes [1].

Globally, the prevalence of prediabetes is increasing and it is expected that by the year 2030, the number of people who will develop prediabetes will be higher than 470 million [5]. In the USA in 2018, the prevalence of prediabetes increased in adult Americans aged 18 or older (88 million)[6].People who are at the risk of prediabetes, which may progress to type2 diabetes, are likely to be older, be overweight or obese, have high blood pressure and have higher lipid levels than people with normal glucose tolerance [7]. Other risk factor includes family history of type 2 diabetes of first- or second-degree relatives, insulin resistance or conditions associated with insulin resistance (hypertension, dyslipidemia, polycystic ovary syndrome) [1]. According to results from a recent meta-analysis, the risk of CVD has been increased in people with prediabetes compared with normoglycemic subjects [8]. Prediabetes is associated with premature mortality [9,10].

Depending on epidemiological and clinical evidence, our study focused on predicting the risk factors associated with prediabetes to avoid or delay the development of type2 diabetes and reduce the associated complication that affect morbidity and mortality.

METHODS

Study outcomes measures

According to ADA guideline, HbA1c is considered the primary clinical target for diabetes, and for this reason, HbA1c will be considered as the primary outcome in this study for measuring prediabetes percent in Al-Bayda, Libya. According to ADA, an A1C level between 5.7 and 6.4% is considered prediabetes [1].

Study design

A cross-sectional study was carried out over a period of four months, beginning on May, 2021 and ending on August, 2021. A blood sample of 300 participants who were visiting AlBida Medical Center, Al-Bayda, Libya for a physical examination by the physician was taken from the participants in different labs in Al-Bayda City. Participants were interviewed and asked to participate in the study if they met inclusion criteria (Age >18 years, Age<45 years, males or females who are not diagnosed with diabetes mellitus) and exclusion criteria(Type1&Type2 diabetes mellitus, Pregnant women, Women diagnosed with polycystic ovary syndrome, Cancer patient, Chronic use for corticosteroid (more than 3 months), Chronic kidney disease patient).To keep sample homogeneity, all participants were selected from the same socioeconomic class to avoid variation.

Before the beginning of the study, written informed consent was obtained from all participants in the study. Participants in the study were asked about age, gender, weight and Body mass index (BMI), calculated as body weight (kg) divided by body height (m^2). volunteers with BMI< 25kg/m^2 are considered to have normal weight, volunteers with BMI >25kg/m^2 are considered to be overweight, and volunteers with BMI> 30 are considered to be obese [2]. Also, they asked about lifestyle, exercise, smoking, current illness, past medical history, family history, and current medication.

And asked if they have any symptoms affected on kidney, eye, or neuron. That was checked by a physician to detect if there were any micro-vascular complications. Blood samples were collected from all participants in the study. The blood samples were analyzed in the lab for measuring HbA1C.

Measuring HbA1C

HbA1c was quantitively measured by using an ichroma instrument, which is based on fluorescence immunoassay (FIA) to determine HbA1c in human whole blood. The test uses the immunodetection method of forming antigen-antibody complexes and migrates onto the nitrocellulose matrix to be captured by other immobilized antibodies. The more antigen in the sample, the more antigen-antibody complexes form, resulting in a stronger fluorescence signal on detector antibody. The content of glycated hemoglobin is expressed as a percent of the total hemoglobin in the blood.

Statistical analysis

The statistical analysis was performed by using the Statistical Package for social sciences SPSS version 26 (IBM SPSS Statistics-26) by using regression linear and logistic regression analysis. A P-value of less than 0.05 is considered to be statistically significant.

RESULTS

Among the 300 participants shown (Table1), 9 had diabetes, including those who were previously or newly diagnosed (Figure1). The number of participants with prediabetes was 141, with a prevalence of 47.0%. We performed Linear Regression analyses in order to identify the factors associated with prediabetes. We found that age (30-39) and smoking (in males) were associated with prediabetes. When assessing the effect of gender on the risk of prediabetes, we found a significant association between the BMI and female participants (p=0.047).

Table 1. Demographic characteristic of the total study sample (N=300)

Parameter	Total subject
Number of participants	**300**
Age in years	
19-29	**35 (11.7%)**
30-39	**220 (73.3%)**
40-49	**45(15.0%)**
Gender	
Male	**181(60.3%)**
Female	**119(39.7%)**
BMI*	
Normal	**145(48.3%)**
Overweight	**111(37.0%)**
Obese	**44(14.7%)**
Smoking	
No	**157(52.3%)**
Yes	**143(47.7%)**
Diet	
No	**238(94.3%)**
Yes	**17 (5.7%)**
Exercise	
No	**260 (86.7%)**
Yes	**40 (13.3%)**
Family history	
No	**88(29.3%)**
Yes	**212(70.7%)**
Nephropathy	
No	**294(98.0%)**
Yes	**6(2.0%)**
Neuropathy	
No	**260(86.7%)**
Yes	**40 (13.3%)**
Retinopathy	
No	**209(69.7%)**
Yes	**91(30.3%)**

***BMI** *(Body Mass Index): BMI< 25kg/m² normal weight, BMI >25kg/m² are overweight and BMI> 30 are obese)[2].*

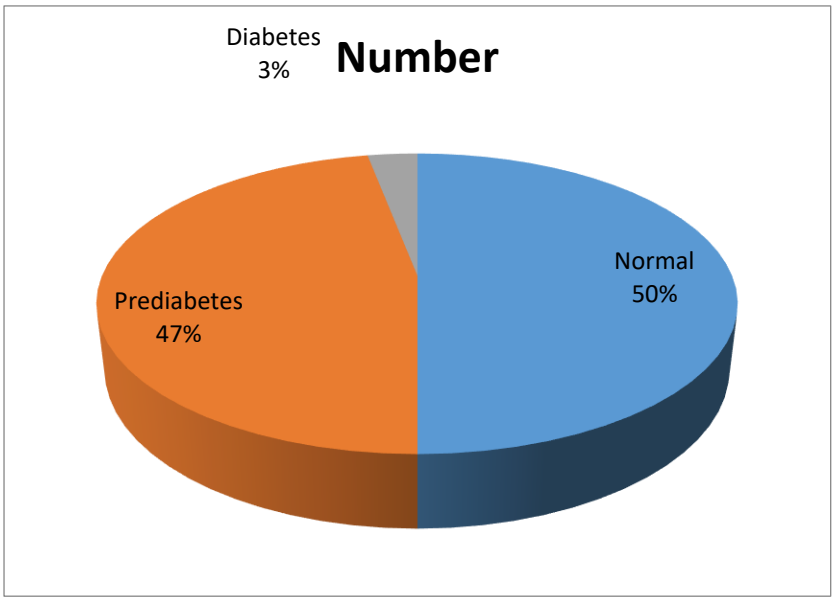

Figure1: The prevalence of prediabetes in whole sample

There was no statistically significant difference in diet, exercise, family history, nephropathy, neuropathy or retinopathy with prediabetes (Table 2).

Table2: Demographic characteristics of subjects with Prediabetes (N=141) and the association between the factors and prediabetes

Parameter	Total subject	P Value
Number of prediabetes subjects	141	
Age in years 19-29 30-39 40-49	 6(2.0%) 121(40.3%) 14(4.7%)	**0.031**
Gender Male Female	 97(32.3%) 44(14.7%)	**0.291**
BMI Normal Overweight Obese	 60(20.0%) 56(18.7%) 25(8.3%)	**0.095**
Smoking No Yes	 51(17.0%) 90(30.0%)	**0.037**
Diet No Yes	 137(45.7%) 4(1.3%)	**0.836**
Exercise No Yes	 134(44.7%) 7(2.3%)	**0.451**
Family history No Yes	 12(4.0%) 129(43.0%)	**0.625**

Nephropathy No Yes	 135(45.0%) 6(2.0%)	**0.991**
Neuropathy No Yes	 103(34.35) 38(12.7%)	**0.891**
Retinopathy No Yes	 71(23.7%) 70(23.3%)	**0.885**

These people with normal HbA1C had a higher risk of developing prediabetes. By using Logistic Regression analysis, there were statistically significant difference in age group (40-49 years), BMI, family history, smoking, neuropathy, retinopathy between the prediabetes and normal groups (Table3).

Table 3: Demographic characteristics of normal subjects (N=150) and the association risk factors between the normal and prediabetes subject:

Parameter	Total subject	P Value
Number of normal subjects	150	
Age in years 19-29 30-39 40-49	 29(9.7%) 94(31.3%) 27(9.0%)	 **0.490** **0.021**
Gender Male Female	 79(26.3%) 71(23.7%)	 **0.192**
BMI Normal Overweight Obese	 85(28.3%) 55(18.3%) 10(3.3%)	 **0.002** **<0.001** **0.004**
Smoking No Yes	 101(33.7%) 49 (16.3%)	 **0.035**
Diet No Yes	 137(45.7%) 13 (4.3%)	 **0.555**
Exercise No Yes	 117(39.0%) 33 (11.0%)	 **0.429**
Family history No Yes	 75(25.0%) 75(25.0%)	 **0.001**
Nephropathy No Yes	 150(50.0%) 0 (0.0%)	 **0.999**
Neuropathy No Yes	 148(49.3) 2(0.7%)	 **<0.001**
Retinopathy No Yes	 129(43.0%) 21(7.0%)	 **<0.001**

DISCUSSION

The current study aimed to estimate the prevalence of prediabetes in the non-diabetic Libyan population and its associated risk factors in Libya. In our study on sample of 300 participants, we found the prevalence of prediabetes to be 47%. The prevalence was elevated in males than in females in this study, which were 32.3% and 14.7 %, respectively, and this was related to previous studies performed in Tianjing city [11].

The age group of 30-39 years (40.3%) was the group which showed the highest prevalence of pre-diabetes. This percent decrease to (4.0%) in the age group of 40-49 years and the age group of 19-29 was (2.0%). This was consistent with a previous study [12] reporting that the prevalence of pre-diabetes peaked in 20-40 years (in males). As previously reported in other parts of the world [13], age was found to be the strongest predictor of prediabetes in our study. Raising age is known to be associated with increased adiposity and decreased muscle mass as a result of the usually noted decrease in physical activity. Such modifies are reported to cause a decrease in insulin sensitivity [14,15]. Individuals Predisposed to metabolic syndrome or prediabetes [16,17].

In our study, BMI was divided into three groups (normal, overweight and obese). The total numbers of overweight and obese people in the pre-diabetes and normal groups were111(44 (14.7%) female with a significant association with BMI (p=0.047) and 35, respectively (the total number was 291, and there were statistically significant differences in being overweight or obese between the pre-diabetes and normal groups (p=<0.001 and p=0.004 respectively) (Table 3).

Increasing facts propose that the excess body fat in overweight or obese people can lead to increased degradation of fat, which results in the production of large amounts of free fatty acids (FFAs). When the level of FFAs was higher in the blood, the capacity of liver tissue for insulin-mediated glucose uptake and utilization was lower, so the blood glucose level was high in circulation [18].

Our study showed there was a risk of diabetes for individuals with normal HbA1C that had a positive family history of diabetes. In comparison between normal and prediabetes the study found that from 150 normal subjects, 50.0% have a positive family history and from 141 prediabetic subjects, 91.5% have a positive family history with a significant relationship between the risk of prediabetes and family history (P=0.001). That is similar to previous study that showed a significant association between family history and progress of prediabetes to T2DM [19].

Another risk factor is smoking and this was also positive in 90 of 141 (30.0%) with prediabetes, especially in males with a significant association (P=0.037) and in the normal subjects we found 49 of 150 were positive smokers (16.3%), P=0.035 that is consistent with Aeschbacher study [20] that found a significant association between healthy individuals who were current smokers with pre-diabetes compared with never smokers. Accordingly, a prior experimental study showed that cigarette smoking directly decreased insulin action and increased insulin resistance [21]. Some studies demonstrate that nicotine and cigarette smoking induce high levels of the stress hormone cortisol. In other words, elevated cortisol levels induce insulin resistance [22]. A new study also recommended that genetic polymorphisms in the nicotinic acetylcholine receptor genes contribute to the incidence of insulin resistance and T2D, increasing the possibility that nicotine dependence may be mechanistically involved in the relationship between smoking and T2D as well [23].

In our study, it was found that a signification association between the development of diabetes and microvascular complications (neuropathy and retinopathy) p=<0.001 and p=<0.001 respectively, is explained by some mechanism related to hyperglycemia and activation of toxic pathways leading to damage in tissues [24]. It is unclear why some people with normal blood glucose become prone to the “premature” development of complications usually detected in patients with long-term DM. It is probable that particular people vary in their response to different levels of glycaemia in relation to the toxic pathways. An alternative possibility is the multiplication effect, in which simultaneous activation of many mechanisms may make some people especially prone to premature damage [25].

The strength of the study was that it was the first study done in Al-Bayda to assess the factors associated with the risk of prediabetes and the assessment of complications was done by a physician, but there are some limitations in our study. We did not use waist circumferences (WC) to assess abdominal obesity, which was important to define the risk of diabetes with obesity. Routine measurement of WC is unfortunately not done in most clinics. This must be resolved, and recommendations to include WC as part of routinely performed clinical assessments should be emphasized.

CONCLUSION

our study showed that the age-standardized prevalence of pre-diabetes was 47% in Al-Bayda, Libya. This result indicates that Al Bayda will face a high incidence of diabetes soon, which will create a heavy economic burden on healthcare. Also, people at the prediabetes phase of age, smokers, and women who are overweight or obese. Moreover, people with normal

results of HbA1C who are older, smokers, or have high BMI, positive family history, or have retinopathy or neuropathy complications should be the focus of diabetes prevention. Health education should be strengthened to support people to change unhealthy dietary habits, and regular screening should be performed to diminish the incidence of new cases of diabetes.

Disclaimer

The article has not been previously presented or published, and is not part of a thesis project.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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