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Original Article

Predictors of conversion from prediabetic state to type 2 diabetes mellitus in Jordan

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1. Introduction

Diabetes mellitus (DM) incidence is increasing worldwide especially in the Middle East, 366 million had diabetes in 2011 and this is predicted to rise to 552 million by 2030.[1] Diabetes mellitus is a multi-factorial disease, characterized by hyperglycemia, resulting from a disturbed insulin secretion, action or both. Diabetes has micro and macro-vascular complications, and about 70–80% of people with diabetes die from cardiovascular disease.[2] Diabetes can be diagnosed by different modalities: fasting blood sugar of 126 mg/dl or above and or by postprandial blood sugar level of 200 mg/dl or above during Oral Glucose Tolerance Test (OGTT) or HbA1c of 6.5 or above.[3]

In the Arab countries, the prevalence of diabetes in Saudi Arabia, Kuwait, and Bahrain is 23.7%, 21.1%, and 19.2% respectively.[4] And in Jordan, the prevalence of Diabetes 17.1%.[5]

Pre-diabetes is an intermediate stage between diabetes mellitus and normal glucose tolerance. It is defined as either impaired fasting blood glucose (IFG) or impaired glucose tolerance (IGT).[3] Current estimates predict 472 million people having Pre-diabetes worldwide by 2030.[4] In overweight adults, up to 22.6% have been shown to have Pre-diabetes.[6] Approximately 5–10% of individuals with Pre-diabetes will progress to diabetes in a year.[7]

In the UK studies demonstrated that the prevalence rate of IGT in people aged between 35 and 65 years was 17%.[8] In the United States, 10–15% of adults are known to suffer from pre-diabetes.[3] while in Jordan, the prevalence of IGT was 9.8% (9.0% in males and 10.3% in females.[5] People with pre-diabetes are at high risk of developing Type 2 Diabetes Mellitus (T2DM) and its complications. Therefore, they are a good target to intervention to prevent diabetes and its complications.[3]

The purpose of this study is to determine rate and factors associated with conversion of pre-diabetes to T2DM in Jordanian patients.

2. Materials and method

A quantitative historical retrospective cohort design was conducted during the period between 1st. December 2013 to the 1st. March 2014 at The National Center for Diabetes Endocrinology and Genetics (NCDEG), Amman, Jordan to determine rate and factors associated with conversion of pre-diabetes to T2DM in Jordanian patients. This design allowed adequate inspection of subjects' data over a designated period.

The NCDEG is a specialized center for treatment, training, development and research. It is primarily a referral center for patients from all over Jordan.

2.1. Inclusion criteria

1. Files of patients who did glucose tolerance were selected between January/2005 till Dec/2013 and found to have pre-diabetes (IFG, IGT or both).
2. HbA1c = 5.7–6.4%.
3. FBS = 100–125 mg/dl.
4. 2. hours blood glucose 140–199 mg/dl during OGTT.
5. Age between 20 and 85 years.

Exclusion criteria: Currently pregnant women at time of data collection, patients who had malignancy, gestational diabetes, patients who had normal HbA1c, FBS and OGTT. In addition to that, we excluded all files of patients who lost follow up for many years then returned with diagnosis of T2DM from the study.

Study Instrument: Screening checklist tool had developed by the researcher to carry out data collection of patients' information from their medical records, which included the following sections:

1. Socio demographic information: Age, Gender, educational level, past medical history, marital status, health insurance, working status, income, smoking, and type of clinic
2. Anthropometric measurement; weight, height, and Waist circumference.
3. Laboratory measurements: fasting blood sugar, 2 h blood glucose during OGTT and HbA1c, total cholesterol, low density lipoprotein, high density lipoprotein and triglyceride level.

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Table 1
Clinical and relevant characteristics of study participants, N = 1002.

Variable	Mean	S.D	Median	Range
Weight at baseline (kg)	82,14	15.9	81	35–142
Weight at data collection (kg)	80,145	16	78	41–152
Height at baseline (cm)	159,278	8.4	158	134–192
Height at data collection (cm)	159,449	8.2	158	141–192
BMI at baseline (kg/m^2)	32.705	5.7	32	19–57.1
BMI data collection (kg/m^2)	31.869	5.7	31	17.5–57
W.C at baseline (cm)	99.858	11.8	100	67–141
W.C data collection (cm)	96.201	11.6	96	54–142
HbA1c at baseline (%)	5.8	0.3	5.8	4.4–6.1
HbA1c data collection (%)	5.7	0.54	5.7	4–11.8
FBS at baseline (mg/dl)	105.5	10	104	78.8–119.6
FBS data collection (mg/dl)	106.379	13.3	105	69–170
RBS at baseline(mg/dl)	153.9	20.8	152	90–199
RBS data collection (mg/dl)	140.3	25	140	69–270

Table 2
Characteristics among study participants who are having complications, N = 1002.

Variable		Frequency	%
Dyslipidaemia	NO	478	47.7
	YES	524	52.3
HTN	NO	561	55.3
	YES	453	44.7
History of Cardiac Disease	NO	951	94.9
	YES	51	5.1
HTN Medication	No	594	59.3
	Yes	408	40.7

Data analysis: Statistical analysis had carried out using (SPSS, version 20).

Ethical Considerations: Data collected after the approval by the ethical committee in National Center for Diabetes Endocrinology and Genetics.

3. Results

Total Number of screened medical records were 1850, 1002 records met eligibility criteria of the study that characterized as follows: 120 participants with IFG, 258 participants with IGT and 624 who had both IFG/IGT.

The socio-demographic characteristics of the study sample medical records showed that 78.1 (n = 783) were female patients and 21.9 (n = 219) were males. Average mean age of the selected patients was 54.3 years (SD = 11.7) with an age ranging from 20 to 85 years. The ages of participants were recorded at the beginning of the study and the follow up done for 8 years.

Most of study participants were nonsmokers 80.7% (n = 809) and only 19.3% (n = 193) were smokers. Almost two third of participants had less than BSC degree 61.1% (n = 612) at baseline visit.

Around 83% of the study participants were insured and 52.3% were unemployed. In addition, the majority of the studied participants 76.7% (n = 769) were married.

Also more than half of the study participants 53.8% (n = 539) had family history of D.M.

The conversion rate from pre-diabetes to T2DM was 11.7%. Of those who developed T2DM (n = 118), nine patients (7.5%) were having IFG level only, 18 patients (7%) were having IGT only and ninety-two (14.4%) were having both IFG/IGT.

As shown in Table 1, the mean of baseline BMI was 32.7 (±5.6); the mean baseline HbA1c was 5.8% (±0.3); while the mean current HbA1c was 5.7% (±0.54). Additionally**,** the mean baseline waist circumference was 99.85 (±11.8); while the mean waist circumference at data collection time was 96.2 (±11.6).

Moreover, the mean FBS at baseline was 105.5 mg/dl (±10) while the mean FBS at data collection was 106.4 mg/dl (±13.3). Fortunately, 88.1% of all patients were compliant to follow up visit.

As shown in Table 2, almost 45% of the study participants were having hypertension, 40.7% of them were on antihypertensive medications. In this study, 52.3% (n = 524) of the participants had dyslipidaemia, and 5.1% (n = 51) of them had a history of cardiac disease.

As shown in Table 3, the only factors that were associated with conversion to diabetes were: gender, education, smoking, waist circumference, FBS, glucose level at baseline visit, and HbA1c.

Table 3
Multivariate analysis of significant factors associated with patients converted to diabetes, N = 1002.

Variable		Frequency	%	HR	(95%CI)	*P*-Value*
Gender:	Male	219	21.9	1	0.37–0.81	0.003
	Female	783	78.1	0.55		
Education	Less than BSC	612	61.1	1	0.45–1.02	0.006
	Higher than BSC	390	38.9	0.68		
Smoking:	No	809	80.7	1	1.006–2.33	0.047
	YES	193	19.3	1.53		
Waist circumference at baseline				1.02	1.005–1.04	0.009
Fasting blood sugar				1.03	1.02–1.05	<0.001
Glucose at baseline				1.02	1.002–1.03	0.029
HbA1C at baseline				3.36	1.80–6.27	<0.001
Family history of diabetes	No	539	53.8	1	0.66–0.95	0.84
	YES	463	46.2	0.93		
Biguanides	NO			1	0.76–1.75	0.317
	YES			1.15		

* Significance level was set at (P value = 0.05).

4. Discussion

In this study, we studied factors associated with conversion of pre-diabetes to T2DM in Jordanian patients using a historical retrospective cohort design.

The results of this study are comparable to those reports from Diabetes Program Prevention (DPP).[9] The conversion rate in this study was higher than those reported from many other populations such as in Pima India study on other populations.[10] Participants with both IFG/IGT have been at highest risk of conversion from pre-diabetes to T2DM, indicating that an elevation of FBS and HbA1c were strongly related to progression to T2DM.[11]

This study showed that the conversion rate from pre-diabetes to T2DM was 11.7%, which goes with the results of Lorenzo et al (2010), who found that the conversion rate was 15.5%. A higher conversion rate in their study may be due to strong family history of T2DM among participants who were converted to T2DM.[12] In addition to higher risk group ethnicity that was included in their study. While in Nichols study (2007) the conversion rate from impaired fasting glucose to T2DM was lower than this study which may be attributed to the old criteria of ADA (2003).[11,3]

In the Strong Heart Study after a median 7.8 years follow up, 36.3% of pre-diabetes developed T2DM.[13] Similar to these results participants with both IFG and IGT at baseline had highest incidence of diabetes upon follow-up.

In agreement with this finding, 7.5% of participants with IFG developed diabetes and 7% of those with IGT developed diabetes. A study of diabetes and its complication in Pima Indian residents showed that the five years incidence of diabetes was higher in IFG than IGT (37 vs. 24%) reaching a conclusion that IFG defines a higher risk category than IGT.[14]

Results of this study confirmed that waist circumference, FBS, HbA1c, smoking, education, and gender were predictors of diabetes. In agreement with these findings, several studies reported associated factors related to conversion from pre-diabetes to T2DM. On the other hand, the reported results by Wang et al. (2010) in the Strong Heart Study showed that diabetes incidence among those with pre-diabetes was higher in men than women, which is in contrary to our results in this study, and this finding was explained by higher adiposity and less physical activity among women.[13] Also, Nichols et. al found that young age and female sex predicted the progression to T2DM in contrary to our findings.[11] The findings of this study could be explained by the fact that the majority of participants were females (n = 783).

Smoking is now proven as an independent risk factor for diabetes; it increases the risk of complication for example heart disease, stroke and diabetic nephropathy.[15] Also, smoking is proven a risk factor for insulin resistance and in this study, the hazard risk for conversion of pre-diabetes to T2DM is almost 1.5 times higher in smokers compared to non-smokers. Patients with high waist circumference were found to be 1.02 times more likely to have hazards of conversion of pre-diabetes to T2DM compared to those with normal waist circumference in agreement with other studies.[13,16] In our study BMI was not found to be one of the predictors of conversion of pre-diabetes to T2DM.

This study revealed that the strong predictor related to conversion of pre-diabetes to T2DM was the baseline HbA1c level, an increase in HbA1c by 1 unit at baseline was associated with three folds increase in risk of conversion to T2DM.

In this study after multivariate analysis of significant association with conversion of pre-diabetes to T2DM, the higher baseline FBS was in association with increased risk of conversion. Almost similar to the finding of Dankner and his colleagues in which they found that 25.9% survivals had progressed to diabetes during 20 years follow up period and FPG was a predictor of 20 years incidence of diabetes.[17]

5. Conclusion

It was found that the conversion rate from pre-diabetes to T2DM among study participants was 11.7%. Progression to T2DM was strongly associated with male sex, elevated waist circumference, smoking, level of education, baseline FBS and HbA1c. The result of this study provides further evidence for the needs to implement strategies to prevent the conversion to T2DM as a national strategy. HbA1c level was one of the strongest predictor of developing T2DM which is an easy laboratory investigation does not need fasting in comparison to a costly and difficult procedure as OGTT and insulin assay.

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