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RESEARCH ARTICLE

Role of Haemoglobin A_1C in Diagnosis of Prediabetes in a Sample of Egyptian Population

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Abstract

Background: Prediabetes, typically is defined as blood glucose concentrations higher than normal, but lower than diabetes thresholds, it is a high-risk state for diabetes development. Glycosylated haemoglobin (A1C) is a form of hemoglobin that is measured primarily to identify the average plasma glucose concentration over prolonged periods. The A1C assay provides an accurate, precise measure of chronic glycaemic levels, and correlates with the risk of diabetes complications. Researches had shown differences in A1C among races especially in detection of prediabetic cases. We aimed to assess the incidence of prediabetes in Al-Salhya Al-Gededa city, Al-Sharkia governorate, Egypt and to evaluate the role of A1C in detection of prediabetic patients. **Subjects and methods:** This was achieved through screening of 550 subjects with high risk factors of diabetes mellitus, (100) subject met criteria of prediabetes were subjected to thorough history taking, full clinical examination and calculation of body mass index, Complete blood picture (CBC), lipid profile and A1C level. **Results:** 100 (18.2%) 0f the 550 participants were diagnosed to have prediabetes {impaired fasting glucose (IFG) and or impaired glucose tolerance (IGT)}. Using A1C for diagnosis, 49 (9%) were within the prediabetes range (A1C 5.7–6.4%). Overweight was the most frequent risk factor (92%) of the prediabetic patients. There was good correlation between A1C, FBG and PPBG in follow up of prediabetic subjects. However, sensitivity and specificity of A1C in diagnosis of prediabetes was lower in comparison to PPBG (58.2% & 69.7%) alone but was higher when combined with FBG (89.6 % & 69.7%). **Conclusion:** In conclusion, in Al Salhyia Al Gededa city, Al-Sharkia governorate, Egypt, prediabetes represents a considerable number of cases. A1C is feasible tool for diagnosis of prediabetes however; its specificity is lower than the OGTT needing further studies. Combined A1C, FPG and or PPBG measurement may be the best option to detect prediabetic cases in Arabs regions especially Egypt.

Introduction:-

The protocols for screening, diagnosis, and identification of individuals at-risk for diabetes and prediabetes are changing. Past policies focused exclusively on tests that examined glucose in blood serum, such as the fasting blood glucose and 2 hour oral glucose tolerance test (OGTT) (ADA, 2013; ADA 2007).

Research has shown haemoglobin A1C assay (A1C) testing to be effective at diagnosing diabetes (Lindstrom et al., 2003) However, limited evidence exists that demonstrates the effectiveness of using A1C to screen or identify individuals with impaired glucose tolerance (Rohlfing et al., 2002; Stern, et., 2002). Moreover, research has shown differences in A1C between races after adjusting for covariates (Boltri et al., 2003; Christensen et al., 2010).

Many trends have been focused on the use of A1C testing to screen and diagnose individuals for diabetes. However, research has shown the A1C test to be accurate and precise for the diagnosis of diabetes only when A1C exceed 6.5% (Cowie et al., 2010; Peter et al., 2007; Wang et al., 2002).

Limitations exist when using the test alone to identify individuals with impaired glucose tolerance. Individuals with levels below 6.5% are not generally diagnosed with diabetes. However, these same individuals may be at risk for developing diabetes. Early detection of pre-diabetes could lead to measures to halt disease progression and complications. (McCarter, Hempe & Chalew, 2006). The ADA standards of care (2010) highlighted A1C 5.7-6.4 % to diagnose categories of increased risk of diabetes (prediabetes) in high-risk individuals. The guidelines do not comment on whether it should be used alone or in combination, with other tests.

Also, the International Expert Committee, appointed by the American Diabetes Association and European Association for the Study of Diabetes, concluded in 2009 that A1C testing could effectively identify individuals at lower risk for developing diabetes mellitus (DM) (International Expert Committee 2009).

However, the committee did warn of limitations regarding the use of the test, including inconsistencies in correlating the A1C test to fasting glucose results, and the overall cost and availability of the A1C test. Moreover, the committee found that the A1C tests don't accurately or precisely diagnose diabetes compared to other tests, such as oral glucose tolerance testing or average glucose concentrations (McCarter et al., 2004). This research aimed to assess the incidence of prediabetes in Al-Salhya Al-Gededa city, Al-Sharkia governorate, Egypt and to evaluate the role of A1C in detection of prediabetic patients.

Subjects and methods:-

Study population

A cross-sectional study was carried out on a random sample of 550 persons from Al Salhyia Al Gededa city, Al-Sharkia governorate, Egypt. They were randomly selected during the period from January to April, 2015. The study included one hundred subjects with risk factors of type 2 diabetes. They were recruited after screening of the 550 subjects. Risk factors include: Age ≥45 years, Overweight (body mass index ≥25 kg/m2), Family history DM in a first-degree relative, Habitual physical inactivity, History of delivering a baby weighing >4.1 kg (9 lb) or of gestational DM, Hypertension (blood pressure ≥140/90 mmHg), Dyslipidemia defined as a serum high-density lipoprotein cholesterol concentration ≤35 mg/dL (0.9 mmol/L) and/or a serum triglyceride concentration ≥250 mg/dL (2.8 mmol/L), Previously identified A1C ≥5.7 percent, impaired glucose tolerance or impaired fasting glucose and History of Polycystic ovary syndrome or vascular disease (ADA, 2010).

While patients with previously diagnosed with DM, liver cirrhosis, chronic renal failure, chronic debilitating diseases, patient on glucocorticoid therapy, Pregnant and lactating females and patients with cardiovascular or cerebrovascular diseases were all excluded.

All the participants were informed about the objective of the study and their written consents were obtained. This study has been cleared by our Institution Ethics Review Board (IRB) for human studies.

Pre diabetic participants assigned to life style intervention were to achieve and maintain a weight reduction of at least 5% of initial body weight through a healthy low calorie, low fat diet and moderate intensity physical activity (such as brisk walking, for at least 150 minutes per week) (ADA, 2015).

Treatment with metformin was added to life style at a dose of 850 mg taken orally once a day for one month then the dose of metformin was increased to 850 mg twice daily, unless gastrointestinal symptoms warranted a longer titration period (Vague et al., 1994). All *participants* were also followed up after three months.

All Prediabetic participants (100) were subjected to:

Clinical examination:-

Thorough history taking, Full clinical examination. Calculation of body mass index (BMI): BMI = weight (kg)/height (m)². Normal BMI ranges from 18.5 to 24.9, overweight is defined as BMI ≥25 and obesity as BMI ≥30 (WHO, 1995).

Laboratory tests:-

All tests were done in the Central Laboratory (Clinical Pathology Department) of Zagazig Faculty of Medicine:

Complete blood picture (CBC), liver and kidney function tests, fasting blood glucose (FPG), 2 h postprandial blood glucose (PPBG), lipid profile and haemoglobin A1C assay by quantitative colorimetric determination in whole blood.

Statistical analysis:

Data analyzed by SPSS version 16. All data were expressed as means ± SD. Frequency tables expressed as numbers and percentage. To analyse patients' data before and after intervention paired t test was performed. For factor correlation Person Correction was performed. Sensitivity, specificity, Accuracy, predictive values were calculated. All P values < 0.05 are considered significant.

Results:

Screening of 550 risky individuals for type 2 DM revealed that: 44 (8%) individuals have newly diagnosed type 2 DM, defined as fasting blood glucose ≥126mg/dl and post prandial blood glucose ≥200mg/dl, these patients were referred to diabetes outpatient clinic for further evaluation and management, 406 (73.8%) individuals were normoglycemic and 100 (18.2 %) individuals have prediabetes: 64 individuals have impaired fasting glucose (IFG), 67 individuals have impaired glucose tolerance (IGT), while 31 individuals have both IFG & IGT. While only 49 individuals have A1C 5.7-6.4%.

Prediabetes is defined as fasting blood glucose between 100-125mg/dl (IFG) and or post prandial blood glucose between 140-200mg/dl (IGT) (ADA, 2013).

The demographic data of the prediabetic participants **table (1)** showed that overweight (BMI ≥25kg/m²) was the most frequent risk factor, found in 92 participants (92%), followed by hypertension found in 40 participants (40%), then followed by hypercholesterolemia found in 33 participants (33%), while family history of DM found in 30 participants (30%).

Table (1):- Frequency distribution of risk factors among the prediabetic participants (no=100).

Risk factors	Frequency (No=100) & Percentage %
Sex ▪ Male ▪ Female	35 65
Positive family History of DM	30
Overweight (BMI≥25)kg/m²	92
History of hypertension	40
Ischemic heart disease	11
History of Gestational DM	8
Hypertriglyceridemia (TG≥150mg/dl)	31
Hypercholesterolemia ≥ 250mg/dl	33
Abnormal ECG	5
IFG (100-125mg/dl)	64
IGT (140-199mg/dl)	67
A1C (5.7-6.4%)	49

There was highly statistical significant improvement in the mean of BMI, cholesterol, systolic blood pressure, fasting blood glucose and postprandial blood glucose in all 100 prediabetic participants at the end of the study **table (2)**. While when studying the correlation between A1C and BMI, FPG and PPBG before and after intervention **table (3)**, there were statistical significant correlation between A1C and FPG and PPBG.

Table (2):-Paired t test for comparison between pre and post intervention of the prediabetic patients regarding blood pressure, BMI and laboratory investigation (No=100).

		Pre	Post	Paired t test	p. value
		Mean ± SD Range	Mean ± SD		
Age (years)		49.6±3.4 (45-60)			
Blood pressure	Systolic	120.7±14.4 (100-160)	118.2±9.3	3.347	0.001*
	Diastolic	78.2±10.7 (60-100)	77.4±8.7	1.41	0.162
BMI (kg/m²)		29.5±2.8 (24.7-35)	28.2±2.7	14.429	<0.001 **
Cholesterol (mg/dl)		209.1±49.2 (150-300)	197.1±32.3	4.256	<0.001**
Triglycerides (mg/dl)		109.6±48.2 (40-195)	106.5±33.8	1.043	0.299
Fasting blood glucose (mg/dl)		104.6±12.3 (80-125)	102.2±11.1	2.2	0.03*
PP blood glucose (mg/dl)		156.1±22.8 (127-199)	149.9±21.3	2.693	0.008*
A1C (%)		5.6±0.5 (4.5-6.4)	5.56±0.5	0.911	0.365

*highly statistical significance

Table (3):- Correlation between A1C and BMI, FPG and PPBG before and after intervention.

	Pre (A1C)		Post (A1C)	
	r	p.value	R	p.value
BMI	0.108	0.287	0.082	0.418
FPG	0.196	0.051	0.37	<0.001**
PPBG	0.079	0.435	0.539	<0.001**

** highly statistical significance

When studying sensitivity and specificity of A1C compared to PPBG in detection of prediabetic patients **table (4)**, the sensitivity, specificity, positive predictive value, negative predictive value were 58.2, 69.7, 79.6 and 45.1 percent respectively for prediabetes by A1C compared to PPBG. Moreover, the area under the curve (AUC) showed high significance of A1C in detection of prediabetes in relation to PPBG **table (4)**.

When studying sensitivity and specificity of FPG compared to PPBG in detection of prediabetic patients **table (5)**, sensitivity, specificity, positive predictive value, and negative predictive value were 89.6, 87.9, 93.8, and 80.6 percent respectively for prediabetes by FPG compared to PPBG. Moreover, the area under the curve (AUC) showed high statistical significance of FPG in detection of prediabetes compared to PPBG **table (5)**.

When studying sensitivity and specificity of A1C and FPG compared to PPBG in detection of prediabetic patients **table (6)**,The table shows that sensitivity, specificity, positive predictive value, negative predictive value were 89.6, 69.7, 85.7 and 76.7 for A1C and FPG in relation to PPBG in detection of prediabetic patient. Moreover, by studying area under the curve (AUC) there was statistical significance of A1C and FPG in detection of prediabetic patients in relation to PPBG **table (6)**.

Table (4):- Sensitivity and specificity for A1C in comparison to PPBG in detection of prediabetic patients and area under the Curve (AUC) of A1C in detection of prediabetic cases in relation to PPBG.

	PPBG		
	(+ve) cases	(-ve) cases	Total
A1C			
(+ve) cases	39	10	49
(-ve) cases	28	23	51
Total	67	33	100

Sensitivity	58.2%
Specificity	69.7%
Positive predictive value	79.6%
Negative predictive value	45.1 %
Accuracy	62%

	AUC	95% Confidence Interval	p-value
A1C	0.619	0.501-0.737	0.054*

* statistical significance

Table (5): Sensitivity and specificity for FPG in comparison to PPBG in detection of prediabetic patients and area under the Curve (AUC) of IFG in detection of prediabetic cases in relation to PPBG before intervention.

	PPBG		
	(+ve) cases	(-ve) cases	Total
FPG			
(+ve) cases	60	4	64
(-ve) cases	7	29	36
Total	67	33	100

Sensitivity	89.6%
Specificity	87.9%
Positive predictive value	93.8 %
Negative predictive value	80.6 %
Accuracy	89%

	AUC	95% Confidence Interval	p-value
IFG	0.872	0.794-951	<0.001**

* statistical significance

Table (6): Sensitivity and specificity of A1C and FPG in compared to PPBG in detection of prediabetic patients and area under the Curve (AUC) of combined IFG& A1C in detection of prediabetic patients in relation to PPBG..

	PPBG		
	(+ve) cases	(-ve) cases	Total
A1C & FPG			
(+ve) cases	60	10	70
(-ve) cases	7	23	30
Total	67	33	100

Sensitivity	89.6 %
Specificity	69.7 %
Positive predictive value	85.7 %
Negative predictive value	76.7 %
Accuracy	83%

	AUC	95% Confidence Interval	p-value
A1C and IFG	0.85	0.665-1	<0.008*

* statistical significance

Discussion:-

The population-based US National Health and Nutrition Examination Survey (NHANES) suggests that 35% of US adults older than 20 years and 50% of those older than 65 years had prediabetes in 2005–2008, defined by FPG or A1C concentrations. Application of these percentages to the entire US population in 2010 yielded an estimated 79 million adults with prediabetes (Centers for Disease Control and Prevention, 2011). The number of adults with IGT is expected to increase worldwide, reaching 472 million by 2030. The greatest absolute rises are expected in Southeast Asia and the western Pacific region (IDF, 2011).

The International Diabetes Federation (IDF) predicts that by the year 2035, 41.5 million sub-Saharan Africans will have diabetes and 66 million will have prediabetes. This represents a 109% increase in the prevalence of diabetes and is the highest anticipated increase in the world (IDF, 2013).

The high burden and prognostic implications of diabetes have led to increasing attempts to prevent its development. Interventions for individuals and populations at high risk for diabetes or with pre-diabetes are a major focus for these prevention efforts (Narayan and Williamson, 2010).

In clinical practice, FPG is a more commonly used test, compared with an OGTT, because of its logistical advantages. However, IFG requires individuals to fast for at least 8 hours before testing (Viswanath et al., 2006).

The inclusion of A1C is designed to increase the feasibility and dissemination of diabetes screening because it eliminates the need for fasting before testing. This practical advantage is likely to be well received by primary care providers working in environments with increasing constraints. Because A1C, FPG, and OGTT are considered acceptable diagnostic tests for pre-diabetes by the American diabetes association (ADA), there may be a shift toward using A1C alone to identify patients with prediabetes and diabetes.

A1C is the gold standard for monitoring glycaemic control in patients with DM. The A1C assay provides an accurate, precise measure of chronic glycaemic levels, it correlates well with both mean glucose concentration (Nathan et al., 2008) and complications of diabetes (Turner et al., 1998; DCCT Research Group, 1993). The use of this test has been extended to diagnose and screen for DM with the endorsement of several international diabetes societies and the World Health Organization. Starting from 2010, the International Expert Committee and the American Diabetes Association proposed diagnostic criteria for diabetes and prediabetes based on A1C levels. These are A1C ≥6.5% (≥48 mmol/mol) to diagnose DM and between 5.7–6.4% (39–46 mmol/mol) for prediabetes (ADA, 2013).

We have assessed prediabetes in Al-Salhya Al-Gededa in Sharkia, Egypt evaluating the role of A1C in detection of prediabetic patients.

In our study, screening of 550 subjects having risk factors for developing type 2 DM revealed that, the prevalence of prediabetes was found to be 18.2%. This prevalence was higher than that found by DECOD study (2003) that reported that in middle aged people, the prevalence of prediabetes is about 15%, this could be explained that in our study we screened individuals at risk to develop type 2 diabetes rather than the general population.

In contrast, to the prevalence of prediabetes in our results Incani et al., (2015) reported that the prevalence of prediabetes (IFG and or IGT) was about 29.3%, this was in the obesity clinic cohort. This could be explained that in our study the screened group were who have risk factors for type 2 diabetes (i.e. over weight ≥25 kg/m2) rather than obese (i.e. obese ≥30 kg/m2).

In this study the prevalence of newly diagnosed DM is (8%). This was in agreement with that found by Incani et al., (2015) study that reported in the diabetic screening cohort, the prevalence of newly diagnosed DM was about (11.0%). In contrast to Dunstan et al., (2002) who reported lower prevalence of newly diagnosed DM (3.7%), this may be also due to high risk of developing type 2 DM in our participants

In contrast, this is lower than the study of Incani et al., (2015) who reported in the obesity clinic cohort, 173 (29.3%) of the 592 participants were diagnosed with prediabetes (IFG and or IGT). using A1C for diagnosis, 157 (26.5%) were within the prediabetes range (A1C 5.7–6.4%).

Overweight (BMI≥25kg/m2) was the most frequent risk factor in the prediabetic patients in our study, found in 92 subject (92%). The increase in the prevalence of type 2 diabetes is closely linked to the upsurge in obesity. About 90% of type 2 diabetes is attributable to excess weight; furthermore, approximately 197 million people worldwide have impaired glucose tolerance, most commonly because of obesity and the associated metabolic syndrome this number is expected to increase to 420 million by 2025 (Hossain et al., 2007).

Family history of diabetes in first-degree relatives was found in 30 subjects (30%) of prediabetic patients in our study, a disease such as diabetes with a demonstrated genetic component is expected to cluster among relatives. Family history is a reflection of this fact, it reflects the environment, cultural practices, and behaviors shared to some extent among close relatives.

Also, a long term study reported that the cumulative prevalence of type 2 diabetes at age 80 years is about 3.5 times higher (38% vs 11%) for people with a first-degree relative with type 2 diabetes compared to people without any affected relative (Köbberling & Tillil 1982).
In our study, Hypertension was found in 40 subjects (40%) of prediabetic patients (no=100). Hypertension is a disease of the vascular system. Like diabetes, it is associated with Dyslipidemia and obesity, and individuals with hypertension are at an increased risk of cardiovascular complications (Kannel & Wolf, 2008).

Hypertension is also associated with insulin resistance and approximately 50% of hypertensive have altered glucose metabolism. Hypertensive subjects have a significantly higher incidence of impaired glucose tolerance and T2DM compared with normotensive subjects. It is estimated that approximately 15% of hypertensive go on to develop T2DM (Onat et al., 2008).

Prediabetic patients were followed up for 3 months. They followed life style modification program with metformin aimed to weight reduction of 5% of the initial weight. This was done by healthy low carbohydrate, low fat diet and engage in a health activity of moderate intensity, such as brisk walking, for at least 150 minutes per week. Metformin was added in a dose of 850 mg twice daily, the mean body weight of the participants decreased by about 6 kg, with decrease of the mean BMI by about 1.4.

In this study, 57% of prediabetic participants achieved the goal (weight reduction of about 5% of their initial body weights), 82.4% of those (47 subject) remained in the prediabetic state, 15.7% (9 subjects) converted to euglycaemic state and 1.7% (1 subject) converted to T2DM.

While 43% of prediabetic participants were non-compliant (reduction of the initial body weight less than 5%), 76.7% of those non-compliant participants (33 subjects) remained in the prediabetic state, 18.6 %(8 subjects) converted to euglycaemic state and 4.6 %(2 subjects) converted to T2DM. These explain the role of lifestyle modification and or metformin in prevent conversion to DM.

IIanne-Parikka et al., (2008) concluded that weight loss is beneficial for treating all of the components of the metabolic syndrome, including excessive adiposity, Dyslipidemia, hypertension, insulin resistance, and hyperglycemia. The study showed that lifestyle intervention with modest weight loss can prevent or at least postpone T2DM development.

The DPP demonstrated that weight loss was the number 1 predictor of reduction in the incidence of diabetes. For every kilogram of weight loss the risk of diabetes developed was decreased by 16% (Hamman et al., 2006).

In our study, we have evaluated the utility of A1C for predicting prediabetes based on either FPG or 2-hour PG. In this study, With IGT as the reference standard, the sensitivity, specificity, and positive and negative predictive values for prediabetes were 58.2, 69.7, 79.6 and 45.1% by A1C; 89.6, 87.9, 93.8, and 80.6% by FPG; and 89.6, 69.7, 85.7 and 76.7% by A1C and FPG respectively.

The correlation coefficients of A1C with fasting glucose and PPBG in the follow up after lifestyle modification and or metformin were 0.47 (p.value<0.001) and 0.539 (P.value<0.001) respectively.

This was in agreement with Lee et al., (2013), who found that the A1C cutoff point of 5.7% had 48.6% sensitivity and 65.7% specificity and The correlation coefficients (R2 values) of A1C with fasting glucose and 2-h post-load glucose were 0.47 ($P < 0.001$) and 0.54 ($P < 0.001$), respectively.

According to our study, A1C alone could detect about 49% of prediabetic subjects, so about 51% will be miss diagnosed as prediabetic. While FPG and PPBG detect about 64% and 67% respectively; A1C combined with FPG predict about 72% and A1C combined with PPBG predict about 76% of prediabetic. So it may be preferred use of A1C in combination with either FPG or PPBG that could raise the number of detection of prediabetic rather than using alone.

The different pathophysiological mechanisms underlying abnormal glucose homeostasis could explain the differences between A1C, FPG and PPBG that were observed for the diagnosis of prediabetes. Hepatic insulin resistance and defective early-phase insulin secretion characterize IFG, resulting in the loss of control of fasting hepatic glucose production. Alternatively, muscle insulin resistance combined with defective late-phase insulin secretion, with almost normal hepatic insulin sensitivity, characterizes IGT, thus determining post-challenge (Nathan et al., 2007).

Both IFG and IGT show fast glucose changes; A1C, in contrast, represents the chronic exposure to both basal and postprandial hyperglycemia over the previous 2–3 months. A1C, therefore, could reflect a combination of the pathophysiological defects underlying IFG and IGT over time. In fact, (Kramer et al., 2010; Cowie et al., 2010; Carson et al., 2010) observed the highest concordance with A1C when the two conditions of IFG and IGT were present together. These different pathophysiological mechanisms might explain the discordant diagnoses of prediabetes based on FPG, 2 h PG and A1C.

As pointed out by the American Diabetes Association, the characterization of subjects discordantly categorized by A1C or OGTT is warranted, in order to identify variables that could help to indicate the best possible test to be prescribed (ADA, 2013).

The most significant variable that differed between participants discordantly categorized by A1C and OGTT compared with participants concordant for NGT or for prediabetes was their age. Above the age of 55 years, participants were most likely to have both tests above the diagnostic thresholds, whereas participants aged less than 50 years were highly discordant, with just 32.6% of them having A1C in the prediabetes range. Furthermore, male sex was also significantly associated with having both A1C and OGTT tests concordant for prediabetes. Thus, it might be hypothesized that in male subjects above the age of 55 years, A1C could be the test of choice for the diagnosis of prediabetes; whereas in younger subjects, the use of the OGTT might be preferable (Incani et al., 2015).

Measurement of A1C alone in Arabs results in a high proportion of false-negative test results for both diabetes and prediabetes, which may lead to delayed diagnosis and potential progression of diabetes-related complications. FPG and/or OGTT are more appropriate to adequately assess glucose tolerance status in Arabs. Thus, it is preferred to use A1C as a tool for diagnosis rather than screening. However, given to its practicality, the low sensitivity of A1C demonstrated should not preclude its use as a screening tool when obtaining a fasting blood sample is not feasible (Pinelli et al., 2011). Obviously, if possible, the combination of more tests (A1C and FPG) might be the best option (Heianza et al., 2011).

The present study had some limitations. First, the cross-sectional design of the study did not allow measuring long-term outcomes. However, the present results are in line with other studies that have found similar data in longitudinal observations (Heianza et al., 2011; Choi et al., 2011). Second, our results are derived from single blood measurements, reflecting standard clinical practice. Thus, individual and daily changes in FPG and 2h post-OGTT glucose cannot be evaluated, and this is a common limitation of most epidemiological studies.

Conclusion:-

In conclusion, in Al Salhyia Al Gededa city, Al-Sharkia governorate,Egypt, prediabetes represents a considerable number of cases. A1C is feasible tool for diagnosis of prediabetes however; its specificity is lower than the OGTT needing further studies. Combined A1C, FPG and or PPBG measurement may be the best option to detect prediabetic cases in Arabs regions especially Egypt.

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