Scholars LITERATURE

La Prensa Medica Argentina

Research Article

DOI: https://doi.org/10.47275/0032-745X-S2-002
S2-002

Prognostic Significance of Glycosylated Hemoglobin Level in Prediabetic and Newly Diagnosed Diabetic Patients with Acute Coronary syndrome: A Multi-Ethnic Population Study in Saudi Arabia

Mohammed Ahmed Qutub[1] and Alaa Solaiman Algazzar[2]*

[1]Consultant Interventional Cardiology, Division of Cardiology, Department of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
[2]Consultant Cardiologist, Department of Cardiology, Ahmed Maher Teaching Hospital, Alsayeda Zainab, Cairo, Egypt

Abstract

Background: DM is a slowly progressive disease that takes many years to progress from prediabetic to diabetic state. We aimed at finding prognostic significance of varying glycosylated hemoglobin level in prediabetic and newly diagnosed diabetic patients with acute coronary syndrome (ACS) in a multi-ethnic population in Saudi Arabia.

Results: The study evaluated 927 patients presented ACS and no history of DM before. Newly diagnosed DM group showed Significant prevalence of hypertension (p value 0.01) with more prevalence of hypertension in Arabic patients (p value 0.005). New diabetic patients represent statistically significant rise in number of patients having multivessel diseases, slow / no reflow complications or bifurcation lesions (p value 0.031,0.045, and 0.05) respectively. Hospital stay was significantly higher in this group with mean value of 3.38±3.1 (p value < 0.046). Receiver operating characteristic (ROC) curve for HbA1c showed area under the curve was 0.759, and 0.764 with sensitivity 77.2% and 82% and specificity 74.9% and 77% using a cutoff value > 6.08 % and 8% for prediction of dyslipidemia in prediabetic and diabetic groups, respectively.

Conclusion: we identified that HbA1c has a good sensitivity and specificity for prediction of dyslipidemia in prediabetics and newly diagnosed diabetics patients presented with ACS, but it failed to predict dyslipidemia in non-diabetics. The present study showed that high HbA1c level in admission in newly diagnosed diabetic's patients presented by ACS is a potential prognostic factor for multiverses disease and bifurcation lesions.

Keywords: HbA1; Glycosylated Hemoglobin; Acute Coronary Syndrome; Diabetes Mellitus; Dyslipidemia

***Correspondence to:** Alaa Solaiman Algazzar, Department of Cardiology, Ahmed Maher Teaching Hospital, Port said St., Alsayeda Zainab, Cairo, Egypt, E-mail: goodminds@hotmail.com

Citation: Qutub MA, Algazzar AS (2020) Prognostic Significance of Glycosylated Hemoglobin Level in Prediabetic and Newly Diagnosed Diabetic Patients with Acute Coronary syndrome: A Multi-Ethnic Population Study in Saudi Arabia. Prensa Med Argent, S2:002. DOI: https://doi.org/10.47275/0032-745X-S2-002.

Received: June 20, 2020; **Accepted:** July 28, 2020; **Published:** August 01, 2020

Introduction

Previous studies conducted in saudi population showed a high percentage of DM with prevalence of 23.7% to 25.4% among adult population in Saudi Arabia [1]. Diabetes Mellitus (DM) is irreversible disease once established. It is a slowly progressive disease that takes many years to progress from prediabetic to diabetic state [2]. Pre-diabetes or impaired glucose tolerance (IGT) is a state where the blood glucose level is above the normal but below the diagnostic threshold of diabetes mellitus. One study showed that the prediabetic stage can start even from the age of 20 years and above [3]. In the same context, two Saudi studies showed cases of prediabetes with age between 20-44.prediabetic prevalence was 25.5% with strong association with age >45 years [4,5]. Glycated hemoglobin (HbA1c) is a product of non-enzymatic attachment of hexose molecule to the amino terminal valine residue of β-chain of hemoglobin and it is a marker for the average plasma glucose level of previous 2-3 months [6]. Taking into consideration classical risk factors for coronary artery diseases (CAD), elevated HbA1c is one of the independent risk factors for CAD. It was reported that each 1% rise in absolute HbA1c value in the diabetic population leads to 18% increased risk of CVD. This positive correlation between HbA1c and CVD has been established in nondiabetic cases, even within the normal range of HbA1c [7,8].

Poor glycaemic control in DM is a common secondary cause of hyperlipidemia [9]. The abnormal lipid parameters in DM are due to increased free fatty acid secondary to insulin resistance [10,11]. According to American Heart Association, 68% of patients of >65 years with diabetes die due to heart diseases [12]. Many studies have compared and correlated FBG, PPBG and HbA1c with lipid profile in T2DM patients [9]. But few studies are done in prediabetic and newly discovered diabetic patients in this regard.

This study was planned to find out prognostic significance of varying glycosylated hemoglobin level on lipid profile in prediabetic and newly discovered diabetic patients with acute coronary syndrome in a multi-ethnic population in Saudi Arabia.

Methods

The study evaluated 927 patients presented with acute Coronary syndrome (ACS) and no history of DM before. The study was approved by the institutional ethics committee and all patients provided informed consent. We included adult patient ≥ 18 years old and less than 75 years with clinical symptoms of unstable angina (UA), ST segment elevation (STEMI) and non-ST segment elevation (NSTEMI) myocardial infarction according to third universal definition of myocardial infarction [13].

Detailed history, systemic examination and 12 leads ECG were performed for all the participants. Venous blood samples were collected and analyzed for blood glucose level, HbA1c, and lipid profile and cardiac enzymes just after the arrival of the patients to the emergency room. Patients were classified into three groups based on history and HbA1c levels at the time of admission. HbA1c level of 5.7-<6.5% was used to define prediabetes, while DM is ≥6.5%, according to the American Diabetes Association 2016 (14).

Body mass index (BMI) was measured as weight in kilograms divided by height in meters squared (kg/m^2) for all participant being studied. Normal BMI is less than 25 kg/m^2, overweight is considered when BMI is more than 25 kg/m^2 and less than 30, and obese if BMI more than 30 kg/m^2 (15). Contrast induced nephropathy was defined as absolute increase in serum creatinine ≥25% or ≥0.5 mg/dl from baseline at 48 hours after administration of contrast media in the absence of an alternative etiology.

The study excluded patients presented with renal, liver disorders or malignancy, patients with history of IHD or stroke, haemoglobinopathies, hemolytic anemia, chronic malaria, or severe iron deficiency anemia, patients with late presentation MI (longer than 48 hrs. between first symptom and admission) or patients already on anti-lipidemic drugs.

Data Collection

Data was collected and tabulated. Statistical package for social sciences (SPSS) version 25.0 for windows (IBM Corp., Armonk, NY, USA). Data are presented as the Mean ± standard deviation (SD), frequency, and percentage. Categorical variables were compared using the chi-square (χ^2). Continuous variables were compared by one-way ANOVA test with Tukey's test post hoc test to detect differences between subgroups. P<0.05 was considered statistically significant. Correlations between parameters were determined by the Pearson correlation coefficient. Independent variables were determined by multivariate analysis.

Results

Total 927 patients from different ethnicity were included in the study. Patients were categorized into three groups according to HbA1c level. Number of patients included in non-diabetic, prediabetic and newly discovered diabetes groups were 234, 359 and 334 patients, respectively. Baseline clinical characteristics and demographic data were non-significant between groups except for hypertension where newly discovered DM group showed significant difference with (p value 0.01) as shown in table 1. Sub analysis of different ethnic population showed more prevalence of hypertension in Arabic patients with newly diagnosed DM at admission (p value 0.005). Newly discovered diabetic patients showed significantly higher values of triglycerides with mean values of 2.14±2.60 (p value <0.05). As regard to left ventricular EF the analysis showed significant difference among studied groups (f (2,580) = 3465, p value < 0.032). Post hoc tests showed prediabetics and newly diagnosed diabetics differed significantly compared to non-diabetic group. Comparison of GFR and post coronary intervention creatinine among studied groups showed no statistically significant difference in the studied groups (Table 2). Comparing lipid profile in different ethnic population did not show any significant differences (Table 3).

Group of new diabetic patients with HbA1c ≥ 6.5% represent statistically significant rise in number of patients having multivessel diseases, slow flow, no reflow complications or bifurcation lesions. Hospital stay was significantly higher in this group with mean value of 3.38±3.1 (p value < 0.046) (Table 4). Multivariate analysis of patients with HbA1c ≥ 6.5% identified that HbA1c and increased age were independent predictors for multivessel disease (OR=2.64 (P=0.001) and OR=1.2 (P=0.03), for HbA1c and age, respectively) and bifurcation lesions (OR=1.8 (P=0.01) and OR=1.02 (P=0.04), for HbA1c and age, respectively).

Table 1: Comparison of baseline clinical characteristics and demographic data for all studied groups. UA = Unstable Angina, STEMI = ST segment elevation myocardial infarction, Non-STEMI = Non-ST segment elevation myocardial infarction.

Parameter		Nondiabetic HbA1c < 5.7	Pre diabetic HbA1c 5.7 <6.5%	Newly discovered DM HbA1c ≥ 6.5%	P value
Patients Number (%)		234 (25.2)	359 (40.9)	334 (38.08)	
UA		19(2%)	48(5.1%)	44(4.7%)	0.9
STEMI		110(11.8%)	170(18.3%)	136(14.6%)	0.4
NON-STEMI		105(11.3%)	141(15.2%)	154(16.6%)	0.53
Gender n (%)	Male	167(18%)	314(33.9%)	269(29%)	0.15
	Female	67(7.2%)	45(4%)	65(7%)	0.71
Ethinity n (%)	Arabic	111(12%)	212(22.9%)	193(20.8%)	> 0.05
	African	10(1%)	10(1%)	15(1.6%)	
	Indian continent	73(7.8%)	112(12.1%)	115(12.4%)	
	Asian continent	40(4.3%)	25(2.7%)	11(1.2%)	
Age in years (mean ± SD)		55.2±10	56±11.5	58.3±10.9	0.4
Body mass index (kg/m^2)		19±2.7	28.5±2.8	28.4±2.8	0.12
Smokingn (%)		76	119	105	0.11
Family history of CAD n (%)		18	30	27	0.59
Hypertension n (%)		103	173	219	0.005*

Table 2: Comparison of Ejection fraction and laboratory results between studied groups.

Parameter	Non-diabetic HbA1c < 5.7	Pre-diabetic HbA1c 5.7- <6.5%	Newly discovered DMHbA1c ≥ 6.5%	P value
Left Ventricular EF (%)	57.07±13.2	47.5±13.3	47.58±12.3	0.03*
Platelets	257.7±81.4	267.2±81.9	265.7±72.3	0.45
CholesteroL (MEAN ± SD) MMOL/L	4.54±1.24	4.57±1.15	4.57±1.29	0.94
Triglycerides (MEAN ± SD) MMOL/L	1.72±1.27	1.86±1.16	2.14±2.60	0.05*
LDL (MEAN ± SD) MMOL/L	3.02±1.04	3.08±1.02	3.30±1.6	0.72
HDL (MEAN ± SD) MMOL/L	1.04±0.33	1.08±0.73	1.17±0.95	0.81
Troponin	33.56±27.22	52.15±25.75	54.40±28.20	0.35
Total CPK	832.82±	1020.95±	940.41±	0.68
HB A1C (%)	5.31±0.38	6.07±1.03	8.96±2.15	0.001*
Pre PCI-Creatinine (UMOL/L)	80.2±53	70.7±72	98.8±43.6	0.8
Post PCI Creatinine (UMOL/L)	102.5±65	110±64	103.6±76	0.5
GFR ML/MIN/1.73M^2	102.8±37.4	103.4±40.8	98.5±72.6	0.5

Where: EF= ejection fraction, LDL = low density lipoprotein, HDL = High density lipoprotein, CPK = Creatinine phosphokinase, GFR = glomerular filtration rate. * = significant P value.

Table 3: Comparison of lipid profile in different ethnic population.

Parameters	Non-diabetic HbA1c < 5.7		Pre-diabetic HbA1c 5.7– <6.5%		Newly discovered DM HbA1c ≥ 6.5%	
	R	P value	R	P value	R	P value
Cholesterol (mmol/L)	0.035	0.35	0.31	0.05*	0.45	0.04*
Triglycerides (mmol/L)	0.037	0.53	0.59	0.02*	0.53	0.035*
LDL (mmol/L)	0.017	0.78	0.09	0.32	0.002	0.98
HDL (mmol/L)	0.043	0.48	0.06	0.49	0.014	0.82
Troponin	0.05	0.63	0.16	0.14	0.04	0.56
CPK	0.08	0.41	0.024	0.80	0.04	0.59
Platelet	0.09	0.31	0.057	0.54	0.06	0.33
Post PCI creatinine (umol/L)	0.04	0.71	0.11	0.08	0.12	0.09

Table 4: Comparison of cardiac catheterization data between studied groups.

Parameter	Arabic	African	Indian continent	Asian continent	P value
Cholesterol (Mean ± SD) mmol/L	4.4±1.27	4.6±1.04	4.8±1.4	4.4±0.9	0.08
Triglycerides (Mean ± SD) mmol/L	1.7±1.27	1.5±0.86	2±1.2	1.5±0.79	0.45
LDL (Mean ± SD) mmol/L	3.1±1.6	2.9±0.86	3.1±1.11	3.02±0.88	0.99
HDL (Mean ± SD) mmol/L	1.13±0.9	1.09±0.39	0.97±0.23	1.08±0.21	0.87

Table 5: Comparison of lipid profile, cardiac markers, platelets and creatinine with HbA1c in different studied groups.

Parameter	Non-diabetic HbA1c < 5.7	Pre-diabetic HbA1c 5.7- <6.5%	Newly discovered DM HbA1c ≥ 6.5%	P value
Single vessel diseased n (%)	152(16.3%)	194(20.9%)	163(17.5%)	0.07
Two vessels diseased n (%)	54(5.8%)	94(10.1%)	74(7.9%)	0.09
Multivessel disease n (%)	28(3%)	71(7.6%)	97(10.4%)	0.031*
Slow Flow/ No reflow n (%)	9	25(3%)	43(3%)	0.045*
Emergency CABG	0	3(0.3%)	7(0.7%)	0.61
Bifurcation lesion	9(0.9%)	28(3%)	38(4%)	0.05*
Hospital stay (days)	2.7±2.4	3.0±2.8	3.48±3.1	0.046*

The correlation between lipid profile, cardiac markers, platelets and creatinine with HbA1c in different studied groups were analyzed. HbA1c showed significant positive correlation with total cholesterol and triglycerides only in pre-diabetic and newly diagnosed DM as shown in table 5. An elevated HbA1c level was not correlated with a higher incidence of contrast induced nephropathy in all groups.

In prediabetic group, receiver operating characteristic (ROC) curve for HbA1c showed area under the curve was 0.759, with sensitivity 77.2% and specificity 74.9%, using HbA1c cutoff value > 6.08% for prediction of dyslipidemia (Figure 1). In newly diagnosed diabetic patients, receiver operating characteristic (ROC) curve for HbA1c showed area under the curve was 0.764, with sensitivity 82% and specificity 77%, using a cutoff value > 8% for prediction of dyslipidemia (Figure 2).

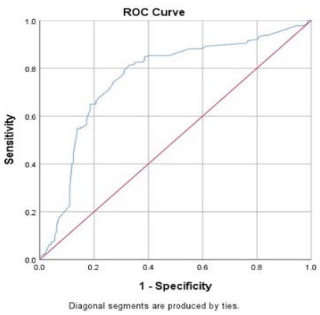

Figure 1: Receiver operating characteristic (ROC) curve for HbA1c showed area under the curve was 0.759, with sensitivity 77.2% and specificity 74.9%, using HbA1c cutoff value > 6.08% for prediction of dyslipidemia in prediabetic group for dyslipidemia.

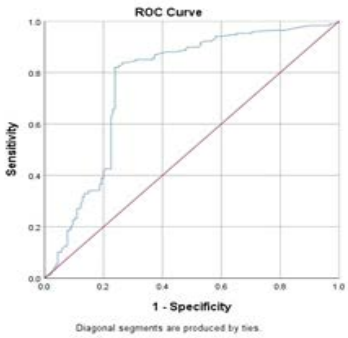

Figure 2: Receiver operating characteristic (ROC) curve for HbA1c showed area under the curve was 0.764, with sensitivity 82% and specificity 77%, using a cutoff value > 8% for prediction of dyslipidemia in newly diagnosed diabetes group.

Discussion

Previous epidemiologic studies have proved greater risk for cardiovascular disease (CVD) among persons with diabetes (16-19). Mansour et al., showed that overall prevalence of DM in Saudi adult population is 23.7%. Incidence of DM among Saudis living in urban areas was 25.5% compared to rural Saudis of 19.5% (p<0.00001). They reported that a considerable number of diabetic patients 1116 (27.9%) were unaware of having DM [2]. There is a strong association between decrease in HbA1c levels in diabetic patients and reduction of the risk of CVD [20,21]. It is estimated that a 0.2% decrease in the HbA1c level could reduce the risk of developing CVD by 10% [7].

The purpose of this study was to evaluate the prognostic value of HbA1c in nondiabetic patients presenting with ACS. Totally, 927 patients presented with ACS from different ethnicity were included. Baseline clinical characteristics and demographic data were non-significant between groups except for hypertension which was significant in newly diagnosed DM group (p value 0.01). Taking into consideration, that DM takes many years to progress from prediabetic to diabetic state, prevalence of hypertension (HTN) in this group is consistent with literature where HTN incidence is more than 50% of patients with (DM) and plays a crucial role in both micro and macrovascular disease in DM [22].

The poor outcomes of patients with newly diagnosed diabetes, although they presented with the same baseline characteristics as patients without diabetes, guide the evidence that metabolic abnormalities contribute to their adverse outcomes [23]. A recent study has found that within new-onset coronary artery disease, the increased cardiovascular risk with prediabetic patients is largely driven by the coexistence of HTN rather than prediabetes alone [24]. Our study showed the prevalence of HTN among Arabic population with newly diagnosed diabetes is higher than that of other ethnicities. It was reported that between Arabic countries, the prevalence of HTN ranged from 16.3% to 44% [25]. A community-based study conducted in Saudi Arabia on 17,230 subjects showed the prevalence of hypertension was 26.1% in crude terms [26].

In the present study, the left ventricular EF was significantly lower in both newly diagnosed diabetics and prediabetics with (p value < 0.032) compared to non-diabetic group. These 2 groups of patients also represent statistically significant rise in number of patients having multivessel diseases, slow flow, no reflow complications or bifurcation lesions and longer hospital stay with p values 0.31, 0.45, 0.05 and 0.046, respectively. Multivariate analysis of patients with HbA1c ≥ 6.5% identified that HbA1c and increased age were independent predictors for multivessel disease (OR=2.64 (P=0.001) and OR=1.2 (P=0.03), for HbA1c and age, respectively) and bifurcation lesions (OR=1.8 (P=0.01) and OR=1.02 (P=0.04), for HbA1c and age, respectively). These findings are consistent with previous studies which proved that hyperglycemia is associated with higher rate of TIMI 0\1 and lower rate of complete revascularization. Chronic hyperglycemia affects platelets function and endothelial function, stimulates inflammation, and result in enhancement of oxidative stress, activation of platelet glycoproteins with abrupt changes in aggregability. It is worth mentioning that hyperglycemia per se in STEMI leads to impaired coronary flow on presentation and after primary coronary intervention [27,28]. All these mechanisms lead to increasing infarct size and reduction of ventricular function [29].

HbA1c showed significant positive correlation with total cholesterol and triglycerides only in pre-diabetic and newly diagnosed DM. lipid profile did not show any significant difference in different ethnic population which strongly indicates that lipid profile was correlated to diabetic state in our study population who share same life style in Saudi Arabia and not related to ethnicity [30]. Al-Kaabba AF, et al. (2012) and colleague showed high prevalence of dyslipidemia among Saudis. He reported high incidence of hypertriglyceridemia affecting 44% of studied population [30] which necessitate to reach the prediabetic population early and evaluate their lipid profile.

Positive correlation of HbA1c level with TC and TG in diabetic patients has been proved in many studies before (31-33).receiver operating characteristic (ROC) curve for HbA1c in our study showed area under the curve was 0.759, with sensitivity 77.2% and specificity 74.9%, using a cutoff value > 6.08% for prediction of dyslipidemia in prediabetics and area under the curve was 0.764, with sensitivity 82% and specificity 77%, using a cutoff value > 8% for prediction of dyslipidemia for newly diagnosed diabetics. On the contrary, this was discordant with Singh et al., who reported no significant difference in total cholesterol, triglyceride in prediabetic individuals with HbA1c between 5.7%-6.4% but this study was conducted on small population of 50 patients without ACS [34].

There is a strong association between HbA1c and subsequent diabetes. In a systematic review analyzed 16 cohort studies included 44,203 individuals with a follow-up interval range between 2.8 and 12 years, the 5-year incidence of developing DM in prediabetics with an HbA1c between 5.5-6.0% was ranging between 9% to 25%. An HbA1c range of 6.0-6.5% had a 5-year incidence of developing diabetes between 25% and 50% and a relative risk 20 times higher compared with an HbA1c of 5.0% [35]. Early recognition of prediabetic people with positive family history will give them the early benefit from lifestyle intervention [36].

This study has several limitations. It was a single center experience and it was conducted on population presented with ACS so conclusions for elective groups with other presentations are needed. Finally follow up over long periods of time is needed.

Conclusion

Our study has identified that HbA1c has a good sensitivity and specificity for prediction of dyslipidemia in prediabetics and newly diagnosed diabetics patients presented with ACS, but it failed to predict dyslipidemia in non-diabetics. Early diagnosis of dyslipidemia can be used as a preventive measure. The present study showed that high HbA1c level in admission in newly diagnosed diabetic's patients presented by ACS is a potential prognostic factor for multivessels disease

and bifurcation lesions. These findings may provide useful information in the therapeutic strategies for this special patient population.

Abbreviations

ACS: Acute coronary syndrome

CVD: cardiovascular disease

DM: Diabetes millitus

HbA1c: Glycosylated Hemoglobin

HTN: Hypertension

IGT: impaired glucose tolerance

NSTEMI: Non-ST segment elevation myocardial infarction

ROC: Receiver operating characteristic

STEMI: ST segment elevation myocardial infarction

TC: Total cholesterol

TG: Triglycerides

References

1. Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY, Al-Harthi SS (2004) Diabetes mellitus in Saudi Arabia. Saudi Med J 25:1603-1610.
2. Lindström J, Peltonen M, Eriksson JG, Ilanne-Parikka P, Aunola S, et al. (2013) Improved lifestyle and decreased diabetes risk over 13 years: long-term follow-up of the randomised Finnish Diabetes Prevention Study (DPS). Diabetologia 56:284-293.
3. Midthjell KL, Lee CM, Langhammer A, Krokstad S, Holmen TL, et al. (2013) Trends in overweight and obesity over 22 years in a large adult population: the HUNT study, Norway. Clin Obes 3:12-20.
4. Aldossari KK, Aldiab A, Al-Zahrani JM, Al-Ghamdi SH, Abdelrazik M, et al. (2018) Prevalence of prediabetes, diabetes, and its associated risk factors among males in Saudi Arabia: a population-based survey. J Diabetes Res 2018: 2194604.
5. Al-Rubeaan K, Al-Manaa HA, Khoja TA, Ahmad NA, Al-Sharqawi AH, et al. (2015) Epidemiology of abnormal glucose metabolism in a country facing its epidemic: SAUDI-DM study. J Diabetes 7:622-632.
6. Gonen B, Rubenstein A, Rochman H, Taneqa SP, Horwitz DL (1977) Haemoglobin A1: an indicator of the metabolic control of diabetic patients. Lancet 310:734-737.
7. VinodMahato R, Gyawali P, Raut PP, Regmi P, Singh KP, et al. (2011) Association between glycaemic control and serum lipid profile in type 2 diabetic patients: glycated haemoglobin as a dual biomarker. Biomed Res 22: 375-380.
8. Syed IA, Khan WA (2011) Glycated haemoglobin – a marker and predictor of cardiovascular disease. J Pak Med Assoc 61: 690-695.
9. Field B, Pinnelli VB (2016) Role of glycated hemoglobin (HBA1c) as a dual marker to predict glycemic status and dyslipidemia in type II diabetes mellitus. Int J Res Med Sci 4:4524-4529.
10. Solano MD, Goldberg RB (2005) Management of diabetic dyslipidemia. Endocrinol Metab Clin 34:1-25.
11. Chahil TJ, Ginsberg HN (2006) Diabetic dyslipidemia. Endocrinol Metab Clin 35:491-510.
12. Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, etal. (2016) Heart disease and stroke statistics-2016 update: a report from the American heart association. Circ 133: e38-e360.
13. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, et al. (2012) Joint ESC/ACCF/AHA/WHF task force for the universal definition of myocardial infarction: third universal definition of myocardial infarction. Eur Heart J 33:2551-2567.
14. American Diabetes Association (2016) Classification and diagnosis of diabetes. Diabetes Care 39:S13-S22.
15. World Health Organization (2008) Waist circumference and waist-hip ratio report of a WHO expert consultation Geneva, Switzerland.
16. Selvin E, Marinopoulos S, Berkenblit G, Rami T, Brancati FL, et al. (2004) Meta-analysis: glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. Ann Intern Med 141:421-431.
17. Rivellese AA, Riccardi G, Vaccaro O (2010) Cardiovascular risk in women with diabetes. Nutr Metab Cardiovasc Dis 20:474-480.
18. Li YW, Aronow WS (2011) Diabetes mellitus and cardiovascular disease. J Clinic Experiment Cardiol 2:2.
19. Duncan BB, Schmidt MI, Pankow JS, Ballantyne CM, Couper D, et al. (2003) Atherosclerosis risk in communities study. Low-grade systemic inflammation and the development of type 2 diabetes: the atherosclerosis risk in communities study. Diabetes 52: 1799-1805.
20. Selvin E, Wattanakit K, Steffes MW, Coresh J, Sharrett AR (2006) HbA1c and peripheral arterial disease in diabetes: the atherosclerosis risk in communities study. Diabetes care 29:877-882.
21. Kawasumi M, Tanaka Y, Uchino H, Shimizu T, Tamura Y, et al. (2006) Strict glycemic control ameliorates the increase of carotid IMT in patients with type 2 diabetes. Endocr J 53:45-50.
22. Sowers JR (2013) Diabetes mellitus and vascular disease. Hypertens 61:943-947.
23. Aguilar D, Solomon SD, Kober L, Rouleau JL, Skali H, et al. (2004) Newly diagnosed and previously known diabetes mellitus and 1-year outcomes of acute myocardial infarction: the VALsartan In Acute myocardial iNfarcTion (VALIANT) trial. Circ 110: 1572-1578.
24. Liu HH, Cao YX, Li S, Guo YL, Zhu CG, et al. (2018) Impacts of prediabetes mellitus alone or plus hypertension on the coronary severity and cardiovascular outcomes. Hypertens 71:1039-1046.
25. Tailakh A, Evangelista LS, Mentes JC, Pike NA, Phillips LR, et al. (2014) Hypertension prevalence, awareness, and control in Arab countries: A systematic review. Nurs Health Sci 16: 126-130.
26. Al-Nozha MM, Abdullah M, Arafah MR, Khalil MZ, Khan NB, et al. (2007) Hypertension in Saudi Arabia. Saudi Med J 28:77-84.
27. Planer D, Witzenbichler B, Guagliumi G, Peruga JZ, Brodie BR, et al. (2013) Impact of hyperglycemia in patients with ST-segment elevation myocardial infarction undergoing percutaneous coronary intervention: the HORIZONS-AMI trial. Int J Cardiol 167:2572-2579.
28. El-sherbiny I, Nabil B, Saber T, Abdelgawad FE (2015) Impact of admission glycosylated hemoglobin A1C on angiographic characteristics and short term clinical outcomes of nondiabetic patients with acute ST-segment elevation myocardial infarction. Cardiol Res Pract 2015: 274-892.
29. Razzaq MK, Rasheed JI, Mohmmad HS (2013) The value of admission glucose and glycosylated hemoglobin in patients with acute coronary syndrome. Iraqi Postgrad Med J 12:75-84.
30. Al-Kaabba AF, Al-Hamdan NA, El Tahir A, Abdalla AM, Saeed AA, et al. (2012) Prevalence and correlates of dyslipidemia among adults in Saudi Arabia: results from a national survey. Open J Endocr Metab Dis 2:89.
31. Erciyas F, Taneli F, Arslan B, Uslu Y (2004) Glycemic control, oxidative stress and lipid profile in children with type 1 diabetes mellitus. Arch Med Res 35: 134-140. Rohlfing CL, Wiedmeyer HM, Little RR, England JD, Tennill A, et al. (2002) Defining the relationship between plasma glucose and HbA1c: analysis of glucose profiles and HbA1c in the diabetes control and complications trial. Diabetes Care 25: 275-278.
32. Khan HA, Sobki SH, Khan SA (2007) Association between glycaemic control and serum lipids profile in type 2 diabetic patients: HbA1c predicts dyslipidaemia. Clin Exp Med 7: 24-29.
33. Singh K, Srivastava N, Singh RL, Mahdi AA (2014) Association between serum lipid profile and glycated hemoglobin in pre-diabetic individuals. Asian J Biomed Pharm Sci 4:30-33.
34. Zhang X, Gregg EW, Williamson DF, Barker LE, Thomas W, et al. (2010) A1C level and future risk of diabetes: a systematic review. Diabetes Care 33:1665-1673.
35. Uusitupa MI, Stančáková A, Peltonen M, Eriksson JG, Lindström J, et al. (2011) Impact of positive family history and genetic risk variants on the incidence of diabetes the Finnish Diabetes Prevention Study. Diabetes care 34:418-423.