Published in final edited form as:

Ann Med. 2016 ; 48(1-2): 34–41. doi:10.3109/07853890.2015.1127406.

Sex differences in the effect of HbA1c-defined diabetes on a wide range of cardiovascular disease risk factors

Tingting Du¹, Gang Yuan¹, Xinrong Zhou¹, and Xingxing Sun^{2,*}

¹Department of Endocrinology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, China

²Department of Anesthesiology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, China

Abstract

Objective—Sex differences in the association of HbA1c and cardiovascular disease (CVD) risk remain controversial. We examined CVD risk profile in HbA1c-defined diabetic and non-diabetic men and women.

Methods—We conducted a cross-sectional analysis of 7139 Chinese adults using data from the China Health and Nutrition Survey 2009.

Results—HbA1c-defined non-diabetic men have a more favorable CVD risk profile than female counterparts. However, HbA1c-defined diabetic men have higher levels of triglyceride, LDL-cholesterol, triglyceride/HDL-cholesterol and lower levels of HDL-cholesterol, be more visceral obese as indicated by visceral adiposity index (VAI) and lipid accumulation product (LAP), and more insulin resistant as assessed by the triglycerides and glucose index (TyG) than HbA1c-defined diabetic women. Furthermore, HbA1c-defined diabetic men showed greater relative differences in ferritin than diabetic women when compared with their non-diabetic counterparts. Statistically significant sex by HbA1c-defined diabetes status interactions were observed for triglyceride, LDL-cholesterol, HDL-cholesterol, triglyceride/HDL cholesterol, VAI, LAP, TyG, and ferritin (all $p < 0.05$). Consideration of VAI or HOMA-IR or both failed to eliminate the sex differences in the association between diabetes and these CVD risk factors.

Conclusions—Men who progressed from HbA1c-defined non-diabetes to HbA1c-defined diabetes have greater metabolic deteriorations and put on more visceral adiposity than women.

Keywords

Cardiovascular risk factors; HbA1c; diabetes; sex

*Corresponding author: Xingxing Sun, MD, PhD, Department of Anesthesiology, Tongji Hospital, Tongji Medical College, Huazhong, University of Science and Technology, Wuhan 430030, China, Tel and Fax: +86 27 85491425, sunxx1984@gmail.com.

Disclosure of Interest

The authors declare no conflict of interest.

Introduction

Cardiovascular disease (CVD) is the leading cause of mortality in individuals with type 2 diabetes mellitus (T2DM) (1, 2). Although glucose-based non-diabetic women tended to have a more favorable CVD risk profile than non-diabetic men, glucose-defined T2DM increases the risk of CVD incidence more prominent in women than in men (3–5), which prompting the idea that many of the female advantages were diminished or abolished in the glucose-defined diabetic state. The possible mechanisms that could account for the sex differences in the effect of fasting plasma glucose (FPG)- or post-oral glucose tolerance test (OGTT) glucose-based diagnosis of diabetes on the excess risk of CVD incidence have been extensively documented (6–9). The majority of these studies evidenced that women transiting from non-diabetes to diabetes need to get the CVD risk profile such as metabolic perturbances, coagulation, and inflammation “travelled” or “deteriorated” more than men (6–9).

More recently, HbA1c (at a value of 6.5% [48 mmol/mol]) has been offered as an alternative diagnostic criterion for T2DM (10, 11). Accumulating studies have shown that HbA1c is likely to have clustered with other CVD risk factors (12). Moreover, the Atherosclerosis Risk in Communities study has shown that HbA1c is superior to FPG for assessment of CVD incidence (13). Since HbA1c and glucose (both FPG and post-OGTT glucose) assess different elements of glucose metabolism (14), HbA1c and glucose identify overlapping but discordant cohorts (15, 16). An important question is whether HbA1c-defined diabetes has greater adverse influence on CVD risk factors in women compared with men, which mimics the pattern observed in glucose-defined diabetes. Therefore, in the present study, we aimed to assess whether established and novel CVD risk factors differ more between HbA1c-defined diabetic and non-diabetic women than between HbA1c-defined diabetic and non-diabetic men.

Materials and Methods

Participants

We used data from the China Health and Nutrition Survey (CHNS) for our analysis. The CHNS is the only large-scale longitudinal, household-based survey in China. Full details of the study have been described elsewhere (17). Briefly, the CHNS rounds were conducted in 1989, 1991, 1993, 1997, 2000, 2004, 2006, and 2009. For each round, a stratified multistage, random cluster process was employed to draw study sample from each of the nine provinces (Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou), covering approximately 56% of China’s population, that vary significantly in terms of geography, economic development, and health status. Each participant provided a written informed consent and the study was approved by the institutional review committees of the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, and the China-Japan Friendship Hospital, Ministry of Health.

Since fasting blood samples were initially collected in 2009, this study examined data from CHNS 2009. All participants were asked to complete a structured questionnaire which

provided information on histories of current and previous illness, and medical treatment. A total of 10,038 adult respondents were surveyed at the 2009 exam, 1,423 did not give blood, 402 were not fasting before blood collection, and 62 were pregnant, resulting in a total of 8,151 individuals with fasting blood samples. Exclusion criteria included pregnancy, participants with extreme BMI ($< 40 \text{ kg/m}^2$), TG ($> 500 \text{ mg/dl}$) or HDL-C ($> 100 \text{ mg/dl}$) values, and no information on age, BMI, or HbA1c. Since we use HbA1c to diagnose diabetes, patients with anemia (hemoglobin $< 13 \text{ g/dl}$ in men, and $< 12 \text{ g/dl}$ in women), and chronic kidney disease (estimated glomerular filtration rate $< 15 \text{ ml/min per } 1.73\text{m}^2$) were excluded. In addition, to avoid the effects of differences in treatment of CVD risk factors between men and women on the results, participants with lipid-lowering medication use, blood pressure (BP)-lowering medication use, and anti-diabetic medication use were also excluded. The remaining 7,139 participants were included in current analysis.

Measurements

Weight, height, waist circumference (WC) and systolic/diastolic blood pressure (BP) were measured following standardized protocols from the World Health Organization (WHO). Weight was measured with participants wearing light clothing on a calibrated beam scale and height was measured without shoes using a portable SECA stadiometer. Body mass index (BMI) was calculated as weight (in kilograms) divided by the square of height (in meters). WC was measured with an inelastic tape at a midpoint between the bottom of the rib cage and the top of the iliac crest at the end of exhalation. BP was measured by trained technicians in triplicate after a 10-min rest, using mercury manometers. The three readings were averaged.

Biochemical measurements

Blood was collected after an at least 8-hour overnight fast. All samples were analyzed in a national central lab in Beijing, with strict quality control. FPG was measured by the GOD-PAP method (Randox Laboratories Ltd, UK). HbA1c was measured with high-performance liquid chromatography using a National Glycohemoglobin Standardization Program certified automated analyzer (model HLC-723 G7; Tosoh, Tokyo, Japan, intra-assay coefficient of variation $< 0.8\%$, inter-assay coefficient of variation $< 0.5\%$) and was standardized according to the Diabetes Control and Complications Trial standard. All lipids (total cholesterol [TC], triglycerides [TG], low density lipoprotein cholesterol [LDL-C], and high density lipoprotein cholesterol [HDL-C]) were directly measured with Hitachi 7600 automated analyzer (Hitachi Inc., Tokyo, Japan). TC, LDL-C, and HDL-C were measured enzymatically (Kyowa, Japan). Non-HDL-C was calculated as TC minus HDL-C. TG was measured by GPO-PAP method (Kyowa, Japan). Lipoprotein (a) was determined with an immunoturbidimetric method (Denka Seiken, Japan). Apo a1 and apo B were measured by immunoturbidimetric method (Randox Laboratories Ltd, UK). Alanine aminotransferase (ALT) was measured enzymatically (Randox Laboratories Ltd, UK). Uric acid (UA) was measured by enzymatic colorimetric method (Randox Laboratories Ltd, UK). Hypersensitive C-reactive protein (hs-CRP) was determined by immunoturbidimetric method (Denka Seiken, Japan reagents). Fasting insulin concentration was measured using the radioimmunity assay (Gamma counter XH-6020, Beijing, China). Homeostasis model

assessment of insulin resistance (HOMA-IR) was calculated by the formula: $\text{HOMA-IR} = \text{fasting insulin (micro-international units per milliliter)} \times \text{FPG (millimoles per liter)} / 22.5$.

Lipid accumulation product (LAP), visceral adiposity index (VAI), and the triglycerides and glucose index (TyG) were calculated using the published formula. LAP (18): Men: $[\text{WC (cm)} - 65] \times [\text{TG (mmol/l)}]$; Women: $[\text{WC (cm)} - 58] \times [\text{TG (mmol/l)}]$. To avoid having nonpositive values for LAP, we reassigned any WC values for men/women that were less than 65/58 cm to 66.0/59.0 cm. VAI (19): Men: $[\text{WC}/39.68 + (1.88 \times \text{BMI})] \times (\text{TG}/1.03) \times (1.31/\text{HDL})$; Women: $[\text{WC}/36.58 + (1.89 \times \text{BMI})] \times (\text{TG}/0.81) \times (1.52/\text{HDL})$, where both TG and HDL levels are expressed in mmol/l. The TyG index (20): $\text{Ln} [\text{TG (mg/dl)} \times \text{FPG (mg/dl)} / 2]$.

Statistical analysis

All statistical analyses were conducted using SPSS software (version 12.0 for windows; SPSS, Chicago, IL, USA). According to 2015 American Diabetes Association (ADA) criteria, diabetes is defined as having HbA1c $\geq 6.5\%$ (48 mmol/mol) (10). Each diabetic patient was matched to three control subjects for sex, age, and BMI using a propensity score analysis. All control persons are 2009 CHNS participants who had HbA1c $< 6.5\%$. There were no statistically significant differences in the total 2009 sample vs the analytical sample in sex or cardiometabolic risk. Continuous variables were expressed as means (SEs). Age- and BMI-adjusted (Table 1), age-, BMI-, and HOMA-IR-adjusted (Table 2), Age- and VAI-adjusted (Table 3), and age-, VAI-, and HOMA-IR-adjusted means (Table 4) were computed by two-way analysis of covariance with gender and diabetes status as the two main effects. Statistical sex $\times$ diabetes interactions in their association with CVD risk factors were computed. Before conducting analyses, insulin was log-transformed (natural logarithm) to approximate normal distributions. Significance was accepted at a two-tailed $P < 0.05$.

Results

Table 1 shows the age- and BMI-adjusted mean levels of a wide range of CVD risk factors by diabetes status separately in men and women. HbA1c-defined non-diabetic men had significantly lower levels of TC, HDL-C, LDL-C, non-HDL-C, VAI, and higher levels of UA, ALT, white blood cell count (WBC), ferritin than their female counterparts, but the magnitude of differences in TC, non-HDL-C, and WBC between HbA1c-defined diabetic men and women were less marked. The higher levels of ferritin and lower levels of HDL-C seen overall in men were more marked in diabetic than in non-diabetic participants. The differences in UA and ALT between non-diabetic men and women were comparable to those between diabetic men and women. The levels of TG, TG/HDL-C, FPG, HbA1c, TyG and lower levels of LDL-C, VAI, and LAP were comparable between HbA1c-defined non-diabetic men and HbA1c-defined non-diabetic women. However, these CVD risk factors were significantly higher in HbA1c-defined diabetic men compared with diabetic women.

Increased CVD risk profile, including levels of WC, TC, TG, LDL-C, Non-HDL-C, TG/HDL-C, ALT, VAI, LAP, FPG, HbA1c, insulin, HOMA-IR, TyG, WBC, hs-CRP, and ferritin, in both male and female HbA1c-defined diabetic subjects were observed. The differences in age- and BMI-adjusted mean levels of TC, TG, LDL-C, HDL-C, Non-HDL-C,

TG/HDL-C, VAI, LAP, ALT, FPG, HbA1c, TyG, and ferritin between diabetic and nondiabetic men were greater than between diabetic and nondiabetic women, while the differences in mean levels of WBC, and hs-CRP between diabetic and nondiabetic women were more striking than between diabetic and nondiabetic men. However, we observed little statistical evidence for sex heterogeneity in the association of diabetes with TC, Non-HDL-C, ALT, and hs-CRP. Statistically significant sex by diabetes status interactions were observed for TG, LDL-C, HDL-C, TG/HDL-C, VAI, LAP, TyG, FPG, HbA1c, WBC, and ferritin (test for sex $\times$ diabetes interaction all p values <0.05). The sex $\times$ diabetes interactions seen for these risk factors changed little with further adjustment for HOMA-IR (Table 2).

Since visceral adiposity is closely related to metabolic disorders, we adjusted for VAI, a good indicator of visceral adiposity, instead of BMI in Table 3. HbA1c-defined non-diabetic men had significantly lower levels of TC, TG, LDL-C, VAI and higher levels of ALT, UA, WBC, ferritin than their female counterparts, but the magnitude of differences in TC, LDL-C, and WBC between HbA1c-defined diabetic men and women were less marked. The higher levels of ALT, UA, and ferritin seen overall in men were more marked in HbA1c-defined diabetic than in non-diabetic participants. The comparable levels of TG/HDL-C, FPG, HbA1c, TyG and lower levels of TG, and VAI seen in non-diabetic men compared with non-diabetic women were significantly higher in HbA1c-defined diabetic men compared with diabetic women. Among men, differences in HDL-C between HbA1c-defined diabetic and non-diabetic counterparts diminished ($P = 0.02$). Among women, differences in TG diminished ($P = 0.55$). The sex $\times$ diabetes interactions noted in Table 1 except for HDL-C remained significant. After additional adjustment for HOMA-IR (Table 4), sex $\times$ diabetes interactions seen for TG, TG/HDL-C, VAI, TyG, FPG, HbA1c, WBC, and ferritin remained essentially unchanged, but the sex $\times$ diabetes interaction for the association with LDL-C and LAP was attenuated ($P=0.05$ and 0.88 , respectively). The sex $\times$ diabetes interaction for the association with UA became statistically significant ($P=0.02$).

Discussion

This is, to our best knowledge, the first population-based study reporting the comparison of a wide range of CVD risk factors between HbA1c-based diabetic and non-diabetic men and women. In the present study, HbA1c-defined non-diabetic men tended to have a more favorable CVD risk profile than female counterparts. However, in the HbA1c-based diabetic state, men were likely than women to have a more atherogenic lipid pattern, be more visceral obese, and more insulin resistant. In addition, HbA1c-defined diabetic men showed greater relative differences in ferritin than diabetic women when compared with their non-diabetic counterparts. Consideration of VAI or HOMA-IR or both failed to reduce or eliminate the sex differences in the association between HbA1c-defined diabetes and these CVD risk factors.

Most studies, in which diabetes is diagnosed by glucose, have shown that diabetes inducing a more adverse CVD risk profile in women compared with men (6–9). The present data showed that HbA1c-defined non-diabetic women tended to have a worse CVD risk profile than non-diabetic men. However, as men go from HbA1c-defined non-diabetes to HbA1c-defined diabetes, they have to “travel” further, i.e. they need to deteriorate their lipid profile

(higher levels of TG, LDL-C, TG/HDL-C, and lower levels of HDL-C), insulin sensitivity as assessed by TyG, and inflammation as assessed by ferritin, put on more visceral adiposity as indicated by VAI and LAP to a greater extent than do women. We observed no sex heterogeneity in the association of HbA1c-defined diabetes with HOMA-IR. However, evidence has shown that TyG is superior to HOMA-IR in estimating insulin resistance evaluated with the euglycemic-hyperinsulinemic method (20). We noted that men with HbA1c-defined diabetes, compared with their non-diabetic counterparts, showed a greater difference in TyG than was seen when comparing female counterparts. The sex heterogeneity in the association of HbA1c-defined diabetes with TyG may be partially explained by the greater difference in visceral adiposity seen between diabetic men and non-diabetic men compared with female counterparts. Circulating ferritin levels have been shown to be positively associated with diabetes and metabolic syndrome (21, 22). Ferritin itself can act as a proinflammatory cytokine (23). In the present study, both HbA1c-defined non-diabetic and diabetic men showed significantly higher levels of ferritin than their non-diabetic and diabetic women and the difference was more pronounced in diabetic patients. Since anemia patients were excluded from the present analysis, ferritin concentration is not a specific marker for iron storage but a marker for systemic inflammation. Thus, the greater increase in ferritin may contribute to a greater CVD risk in HbA1c-defined diabetic men. Although explanations for the sex differences in the effect of HbA1c-defined diabetes on these CVD risk factors remain to be elucidated, it is probably related to different facets of glucose metabolism represented by glucose and HbA1c (14). Since the relationship between insulin sensitivity or β -cell function and HbA1c differs significantly from that obtained using FPG or post-OGTT glucose (24, 25), HbA1c- and glucose-diagnosed diabetes may be different risk phenotypes. Mounting evidence showed poor agreement between HbA1c and glucose when applied to diabetes diagnosis (15, 16), that is, HbA1c and glucose identify different individuals with diabetes to a great extent.

Accumulating studies indicated that HbA1c-defined diabetes often coexisted with poor CVD risk profile (13). In the present study, we showed that HbA1c-defined diabetes induced an adverse CVD risk profile, such as a more atherogenic lipid pattern, more visceral obese, more insulin resistant, and more adverse inflammation in both men and women, supporting the use of HbA1c as a diagnostic test for T2DM. Previous studies examining the relative risk of CVD associated with HbA1c have found conflicting results, with some reporting that the absolute risk of CVD associated with HbA1c was greater in men than in women (26), whereas others reporting equal risk (12). We found that HbA1c-defined diabetes had greater adverse influence on these CVD risk factors in men compared with women. The greater adverse influence of HbA1c-defined diabetes on CVD risk profile in men may confer a greater risk of CVD involvement in men. Our finding is in contrast to the notion that glucose-based diabetes had greater adverse influence on the CVD risk profile in women compared with men (6–9). Using HbA1c to diagnose T2DM resulted in an establishment of a new cluster of diabetic patients (15, 16). The recommendations do not comment on whether clinicians should use the test (glucose and HbA1c) in isolation or in combination to diagnose diabetes. However, the superiority of HbA1c over glucose for predicting CVD incidence and the logistical advantages make HbA1c a clinician's preferred test. HbA1c, which represents chronic exposure to basal and postprandial hyperglycemia, reflects the

nonenzymatic modification of the amino acids on hemoglobin. The accumulation of glycated hemoglobin in tissues may adversely affect vessel walls and induce endothelial cell dysfunction, which play a contributory role in atherosclerosis (27). These characteristics may explain the superiority of HbA1c over glucose for characterizing long-term CVD risk. Hence, introduction of HbA1c in addition to glucose for diabetes diagnosis could have profound implications for sex-specific prevention and treatment of diabetes and CVD.

Our study has several limitations. First, the cross-sectional study design makes it difficult to infer whether the HbA1c-defined diabetes in men requires more adverse changes in lipid profile, visceral adiposity, TyG, and ferritin levels. Second, the cross-sectional nature of this study makes it difficult to infer causality between these greater differences in the CVD risk profile and the greater relative CHD risk among HbA1c-defined diabetic men. However, the strengths of our study include that the data are population-based and several emerging risk factors including inflammation such as ferritin and visceral adiposity were assessed, and that several covariates of interest were evaluated in detail.

In summary, our study documents that HbA1c-defined non-diabetic men tended to have more favorable CVD risk profile than women. Increased CVD risk factors in both male and female HbA1c-defined diabetic subjects were observed. Men who progressed from HbA1c-defined non-diabetes to HbA1c-defined diabetes have greater deterioration in many CVD risk factors and put on more visceral adiposity than women. The greater changes in CVD risk profile were independent of the effects of age, BMI, visceral adiposity, or HOMA-IR. These novel and important observations may help to predict the increased relative CVD risk in HbA1c-defined diabetic men compared with women.

Acknowledgments

We thank the China Health and Nutrition Survey, supported by the NIH (R01-HD30880, DK056350 and R01-HD38700), and the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention, Carolina Population Center, the University of North Carolina at Chapel Hill and the Fogarty International Center for providing the data used here. We also thank the China-Japan Friendship Hospital and Ministry of Health for support for CHNS 2009 survey.

References

1. Nathan DM, Meigs J, Singer DE. The epidemiology of cardiovascular disease in type 2 diabetes mellitus: how sweet it is ... or is it? *Lancet*. 1997; 350(Suppl 1):SI4–9. [PubMed: 9250276]
2. Lotufo PA, Gaziano JM, Chae CU, Ajani UA, Moreno-John G, Buring JE, et al. Diabetes and all-cause and coronary heart disease mortality among US male physicians. *Arch Intern Med*. 2001; 161(2):242–7. [PubMed: 11176738]
3. Juutilainen A, Kortelainen S, Lehto S, Ronnema T, Pyorala K, Laakso M. Gender difference in the impact of type 2 diabetes on coronary heart disease risk. *Diabetes Care*. 2004; 27(12):2898–904. [PubMed: 15562204]
4. Huxley R, Barzi F, Woodward M. Excess risk of fatal coronary heart disease associated with diabetes in men and women: meta-analysis of 37 prospective cohort studies. *BMJ*. 2006; 332(7533): 73–8. [PubMed: 16371403]
5. Peters SA, Huxley RR, Woodward M. Diabetes as risk factor for incident coronary heart disease in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events. *Diabetologia*. 2014; 57(8):1542–51. [PubMed: 24859435]
6. Wannamethee SG, Papacosta O, Lawlor DA, Whincup PH, Lowe GD, Ebrahim S, et al. Do women exhibit greater differences in established and novel risk factors between diabetes and non-diabetes

- than men? The British Regional Heart Study and British Women's Heart Health Study. *Diabetologia*. 2012; 55(1):80–7. [PubMed: 21861177]
7. Williams K, Tchernof A, Hunt KJ, Wagenknecht LE, Haffner SM, Sniderman AD. Diabetes, abdominal adiposity, and atherogenic dyslipoproteinemia in women compared with men. *Diabetes*. 2008; 57(12):3289–96. [PubMed: 18809621]
 8. Donahue RP, Rejman K, Rafelson LB, Dmochowski J, Stranges S, Trevisan M. Sex differences in endothelial function markers before conversion to pre-diabetes: does the clock start ticking earlier among women? The Western New York Study. *Diabetes Care*. 2007; 30(2):354–9. [PubMed: 17259507]
 9. Steinberg HO, Paradisi G, Cronin J, Crowde K, Hempfling A, Hook G, et al. Type II diabetes abrogates sex differences in endothelial function in premenopausal women. *Circulation*. 2000; 101(17):2040–6. [PubMed: 10790344]
 10. American Diabetes Association. (2) Classification and diagnosis of diabetes. *Diabetes Care*. 2015; 38(Suppl):S8–S16.
 11. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy: a World Health Organization Guideline. *Diabetes Res Clin Pract*. 2014; 103(3):341–63. [PubMed: 24847517]
 12. Sakurai M, Saitoh S, Miura K, Nakagawa H, Ohnishi H, Akasaka H, et al. HbA1c and the risks for all-cause and cardiovascular mortality in the general Japanese population: NIPPON DATA90. *Diabetes Care*. 2013; 36(11):3759–65. [PubMed: 23877989]
 13. Selvin E, Steffes MW, Zhu H, Matsushita K, Wagenknecht L, Pankow J, et al. Glycated hemoglobin, diabetes, and cardiovascular risk in nondiabetic adults. *N Engl J Med*. 2010; 362(9):800–11. [PubMed: 20200384]
 14. International Expert Committee. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care*. 2009; 32(7):1327–34. [PubMed: 19502545]
 15. Lipska KJ, De Rekeneire N, Van Ness PH, Johnson KC, Kanaya A, Koster A, et al. Identifying dysglycemic states in older adults: implications of the emerging use of hemoglobin A1c. *J Clin Endocrinol Metab*. 2010; 95(12):5289–95. [PubMed: 20861123]
 16. Mann DM, Carson AP, Shimbo D, Fonseca V, Fox CS, Muntner P. Impact of A1C screening criterion on the diagnosis of pre-diabetes among U.S. adults. *Diabetes Care*. 2010; 33(10):2190–5. [PubMed: 20628087]
 17. Popkin BM, Du S, Zhai F, Zhang B. Cohort Profile: The China Health and Nutrition Survey--monitoring and understanding socio-economic and health change in China, 1989–2011. *Int J Epidemiol*. 2010; 39(6):1435–40. [PubMed: 19887509]
 18. Kahn HS. The “lipid accumulation product” performs better than the body mass index for recognizing cardiovascular risk: a population-based comparison. *BMC Cardiovasc Disord*. 2005; 5:26. [PubMed: 16150143]
 19. Amato MC, Giordano C, Galia M, Criscimanna A, Vitabile S, Midiri M, et al. Visceral Adiposity Index: a reliable indicator of visceral fat function associated with cardiometabolic risk. *Diabetes Care*. 2010; 33(4):920–2. [PubMed: 20067971]
 20. Guerrero-Romero F, Simental-Mendia LE, Gonzalez-Ortiz M, Martinez-Abundis E, Ramos-Zavala MG, Hernandez-Gonzalez SO, et al. The product of triglycerides and glucose, a simple measure of insulin sensitivity. Comparison with the euglycemic-hyperinsulinemic clamp. *J Clin Endocrinol Metab*. 2010; 95(7):3347–51. [PubMed: 20484475]
 21. Sun L, Zong G, Pan A, Ye X, Li H, Yu Z, et al. Elevated plasma ferritin is associated with increased incidence of type 2 diabetes in middle-aged and elderly Chinese adults. *J Nutr*. 2013; 143(9):1459–65. [PubMed: 23902953]
 22. Montonen J, Boeing H, Steffen A, Lehmann R, Fritsche A, Joost HG, et al. Body iron stores and risk of type 2 diabetes: results from the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study. *Diabetologia*. 2012; 55(10):2613–21. [PubMed: 22752055]
 23. Ruddell RG, Hoang-Le D, Barwood JM, Rutherford PS, Piva TJ, Watters DJ, et al. Ferritin functions as a proinflammatory cytokine via iron-independent protein kinase C zeta/nuclear factor kappaB-regulated signaling in rat hepatic stellate cells. *Hepatology*. 2009; 49(3):887–900. [PubMed: 19241483]

24. Heianza Y, Arase Y, Fujihara K, Tsuji H, Saito K, Hsieh SD, et al. High normal HbA(1c) levels were associated with impaired insulin secretion without escalating insulin resistance in Japanese individuals: the Toranomon Hospital Health Management Center Study 8 (TOPICS 8). *Diabet Med.* 2012; 29(10):1285–90. [PubMed: 22486679]
25. Kanat M, Winnier D, Norton L, Arar N, Jenkinson C, Defronzo RA, et al. The relationship between {beta}-cell function and glycated hemoglobin: results from the veterans administration genetic epidemiology study. *Diabetes Care.* 2011; 34(4):1006–10. [PubMed: 21346184]
26. Simmons RK, Sharp S, Boekholdt SM, Sargeant LA, Khaw KT, Wareham NJ, et al. Evaluation of the Framingham risk score in the European Prospective Investigation of Cancer-Norfolk cohort: does adding glycated hemoglobin improve the prediction of coronary heart disease events? *Arch Intern Med.* 2008; 168(11):1209–16. [PubMed: 18541829]
27. Moura FA, Figueiredo VN, Teles BS, Barbosa MA, Pereira LR, Costa AP, et al. Glycosylated hemoglobin is associated with decreased endothelial function, high inflammatory response, and adverse clinical outcome in non-diabetic STEMI patients. *Atherosclerosis.* 2015; 243(1):124–30. [PubMed: 26385505]

Key messages

1. HbA1c-defined non-diabetic men have a more favorable CVD risk profile than female counterparts.
2. Men have to undergo a greater metabolic deterioration to develop HbA1c-defined diabetes than do women.
3. Men have to put on more visceral adiposity to develop HbA1c-defined diabetes than do women.

Age, BMI, and age- and BMI-adjusted mean levels of studied cardiovascular disease risk factors according to sex and HbA1c-defined diabetes status

Table 1

	Women			Men			Women vs men		
	HbA1c	6.5%	HbA1c < 6.5%	P value*	HbA1c	6.5%	HbA1c < 6.5%	P value*	P (HbA1c < 6.5%)
	N	308	924		287	861			
Age (years)	61.8±0.7	61.1±0.4	0.35		60.6±0.7	60.0±0.4	0.66	0.07	0.12
BMI (kg/m ²)	26.0±0.2	25.8±0.1	0.32		25.6±0.2	25.6±0.1	0.82	0.17	0.18
WC (cm)	89.3±0.4	87.2±0.2	<0.001		92.4±0.4	90.5±0.2	<0.001	<0.001	<0.001
SBP (mmHg)	134.6±1	132.5±0.6	0.08		136.3±1.1	132.8±0.6	<0.001	0.24	0.72
DBP (mmHg)	83.9±0.6	83.1±0.4	0.27		86.2±0.6	85.2±0.4	0.20	0.01	<0.001
TC (mmol/l)	5.5±0.1	5.2±0.0	<0.001		5.4±0.1	4.9±0.0	<0.001	0.13	<0.001
TG (mmol/l)	2.1±0.1	1.7±0.0	<0.001		2.9±0.1	1.7±0.1	<0.001	<0.001	0.85
LDL-C (mmol/l)	3.5±0.1	3.3±0.0	<0.001		3.7±0.1	3.1±0.0	<0.001	<0.001	<0.001
HDL-C (mmol/l)	1.4±0.0	1.4±0.0	0.09		1.2±0.0	1.3±0.0	<0.001	0.00	<0.001
TG/HDL	1.8±0.1	1.4±0.1	0.01		3.0±0.1	1.5±0.1	<0.001	<0.001	0.30
Non-HDL (mmol/l)	4.1±0.1	3.7±0.0	<0.001		4.1±0.1	3.6±0.0	<0.001	0.86	<0.001
Lipo a (mg/dl)	16.9±1.2	16.0±0.7	0.54		12.9±1.2	14.1±0.7	0.37	0.02	0.05
Apo B (g/l)	1.1±0.0	1.0±0.0	0.13		1.0±0.0	1.0±0.0	0.11	0.09	0.06
Apo a1 (g/l)	1.1±0.0	1.2±0.0	0.10		1.0±0.0	1.2±0.0	0.16	0.07	0.25
Apo B/apo a1	1.0±0.0	0.9±0.0	0.11		1.0±0.0	0.9±0.0	<0.15	0.45	0.52
FPG (mmol/l)	7.9±0.1	5.3±0.1	<0.001		8.7±0.1	5.3±0.1	<0.001	<0.001	0.81
HbA1c (%)	7.7±0.1	5.6±0.0	<0.001		8.0±0.1	5.6±0.0	<0.001	0.00	0.22
HbA1c (mmol/mol) [#]	61	38	<0.001		64	38	<0.001	0.00	0.22
Insulin	2.7±0.0	2.5±0.0	<0.001		2.7±0.0	2.5±0.0	<0.001	0.98	0.60
HOMA-IR	8.6±0.5	3.7±0.3	<0.001		8.7±0.5	3.8±0.3	<0.001	0.93	0.76
TyG index	9.3±0.0	8.8±0.0	<0.001		9.6±0.0	8.7±0.0	<0.001	<0.001	0.57
ALT	26.6±1.0	22.2±0.6	<0.001		29.9±1	25.9±0.6	0.01	<0.001	<0.001
VAI	3.6±0.2	2.7±0.1	<0.001		4.0±0.2	2.0±0.1	<0.001	0.11	<0.001
LAP	69.2±2.8	52.2±1.6	<0.001		81.3±2.9	47.4±1.7	<0.001	<0.001	0.04
UA (mmol/l)	297.9±6	290±3.4	0.25		376.7±6.2	366.4±3.6	0.15	<0.001	<0.001
WBC (10 ⁹ /ml)	7.0±0.1	6.2±0.1	<0.001		6.9±0.1	6.5±0.1	<0.001	0.91	<0.001

	Women			Men			Women vs men		
	6.5%			6.5%			6.5%		
	HbA1c	HbA1c < 6.5%	P value *	HbA1c	HbA1c < 6.5%	P value *	P (HbA1c < 6.5%)	P (HbA1c < 6.5%)	P interaction §
Hs-CRP (mg/l)	5.0±0.5	2.6±0.3	< 0.001	4.9±0.5	3.1±0.3	< 0.001	0.91	0.25	0.50
Ferritin (ng/ml)	157.7±12	112.6±6.9	< 0.001	317.9±12.4	207.4±7.2	< 0.001	< 0.001	< 0.001	< 0.001

Data are means±SEs.

Data are means.

BMI, Body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglycerides; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; Apo B: apolipoprotein B; Apo A1: apolipoprotein A1; FPG, fasting plasma glucose; TyG index: the product of triglycerides and fasting glucose; ALT, alanine aminotransferase; VAI: visceral adiposity index; LAP: lipid accumulation product; UA, uric acid; WBC, white blood cell count; Hs-CRP, hypersensitive C-reactive protein.

* p value for difference between diabetic and non-diabetic participants

§ Interaction of sex by diabetes status

Age-, BMI-, and HOMA-IR-adjusted mean levels of studied cardiovascular disease risk factors according to sex and HbA1c-defined diabetes status

Table 2

	Women			Men			Women vs men		
	HbA1c < 6.5%			HbA1c < 6.5%			HbA1c < 6.5%		
	HbA1c	6.5%	P value*	HbA1c	6.5%	P value*	P (HbA1c < 6.5%)	P (HbA1c < 6.5%)	P interaction [§]
WC (cm)	89.2±0.4	87.3±0.2	<0.001	92.3±0.4	90.6±0.2	<0.001	<0.001	<0.001	0.76
SBP (mmHg)	134.4±1	132.6±0.6	0.12	136.2±1.1	132.9±0.6	0.01	0.24	0.72	0.40
DBP (mmHg)	83.9±0.6	83.1±0.4	0.27	86.2±0.6	85.2±0.4	0.20	0.01	<0.001	0.86
TC (mmol/l)	5.5±0.1	5.2±0.0	<0.001	5.4±0.1	4.9±0.0	<0.001	0.13	<0.001	0.35
TG (mmol/l)	2.1±0.1	1.7±0.0	<0.001	2.9±0.1	1.7±0.1	<0.001	<0.001	0.87	<0.001
LDL-C (mmol/l)	3.5±0.1	3.3±0.0	<0.001	3.6±0.1	3.1±0.0	0.94	<0.001	<0.001	0.01
HDL-C (mmol/l)	1.4±0.0	1.4±0.0	0.28	1.1±0.0	1.3±0.0	0.03	<0.001	<0.001	0.02
TG/HDL	1.7±0.1	1.4±0.1	0.04	2.9±0.1	1.5±0.1	<0.001	<0.001	0.31	<0.001
Non-HDL (mmol/l)	4.1±0.1	3.7±0.0	<0.001	4.1±0.1	3.6±0.0	<0.001	0.86	<0.001	0.20
Lipo a (mg/dl)	17.0±1.2	16.0±0.7	0.46	13.0±1.2	14.1±0.7	0.46	0.02	0.05	0.28
Apo B (g/l)	1.1±0.0	1.0±0.0	<0.001	1.0±0.0	1.0±0.0	<0.001	<0.001	0.02	0.21
Apo a1 (g/l)	1.1±0.0	1.2±0.0	0.19	1.1±0.0	1.1±0.0	<0.001	0.02	0.26	0.15
Apo B/apo a1	1.0±0.0	0.9±0.0	<0.001	1.0±0.0	0.9±0.0	<0.001	0.45	0.53	0.73
FPG (mmol/l)	7.6±0.1	5.4±0.1	<0.001	8.4±0.1	5.4±0.1	<0.001	<0.001	0.72	<0.001
HbA1c (%)	7.7±0.1	5.6±0.0	<0.001	7.9±0.1	5.6±0.0	<0.001	<0.001	0.20	<0.001
HbA1c (mmol/mol) [#]	61	38	<0.001	63	38	<0.001	<0.001	0.20	<0.001
Insulin	2.6±0.0	2.6±0.0	0.71	2.6±0.0	2.5±0.0	0.34	0.97	0.35	0.66
HOMA-IR	8.6±0.5	3.7±0.3	<0.001	8.7±0.5	3.8±0.3	<0.001	0.93	0.76	0.94
TyG index	9.3±0.0	8.8±0.0	<0.001	9.5±0.0	8.8±0.0	<0.001	<0.001	0.52	<0.001
ALT	25.0±1	22.3±0.6	<0.001	28.7±1	26±0.6	0.02	0.01	<0.001	0.48
VAI	3.5±0.2	2.7±0.1	<0.001	3.9±0.2	2.0±0.1	<0.001	0.11	<0.001	<0.001
LAP	67.6±2.9	52.8±1.6	<0.001	79.7±3	47.9±1.7	<0.001	<0.001	0.04	<0.001
UA (mmol/l)	294.3±6	291.3±3.5	0.66	373.0±6.2	367.6±3.6	0.45	<0.001	<0.001	0.81
WBC (10 ⁹ /ml)	6.9±0.1	6.2±0.1	<0.001	6.9±0.1	6.5±0.1	0.01	0.91	<0.001	0.04
Hs-CRP (mg/l)	4.7±0.5	2.7±0.3	<0.001	4.6±0.5	3.2±0.3	0.02	0.91	0.26	0.50
Ferritin (ng/ml)	154.2±12.1	113.8±7	<0.001	314.4±12.5	208.5±7.2	<0.001	<0.001	<0.001	<0.001

Data are means±SEs.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

#Data are means.

BMI, Body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglycerides; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; Apo B, apolipoprotein B; Apo A1, apolipoprotein A1; FPG, fasting plasma glucose; TyG index, the product of triglycerides and fasting glucose; ALT, alanine aminotransferase; VAI, visceral adiposity index; LAP, lipid accumulation product; UA, uric acid; WBC, white blood cell count; Hs-CRP, hypersensitive C-reactive protein.

* p value for difference between diabetic and non-diabetic participants

[§]Interaction of sex by diabetes status

Age- and VAI-adjusted mean levels of studied cardiovascular disease risk factors according to sex and HbA1c-defined diabetes status

Table 3

	Women			Men			Women vs men		
	HbA1c			HbA1c			P (HbA1c < 6.5%)		
	HbA1c	6.5%	HbA1c < 6.5%	HbA1c	6.5%	HbA1c < 6.5%	P value*	P (HbA1c < 6.5%)	P interaction [§]
WC (cm)	89.4±0.6	87.5±0.3	<0.001	91.3±0.6	90.5±0.3	0.25	0.02	<0.001	0.76
SBP (mmHg)	134.7±1.1	132.8±0.6	0.13	135.5±1.1	132.9±0.6	0.04	0.61	0.95	0.40
DBP (mmHg)	83.9±0.7	83.2±0.4	0.39	85.5±0.7	85.3±0.4	0.78	0.08	<0.001	0.86
TC (mmol/l)	5.4±0.1	5.2±0.0	0.00	5.3±0.1	5.0±0.0	<0.001	0.04	<0.001	0.35
TG (mmol/l)	1.7±0.0	1.7±0.0	0.55	2.3±0.0	1.6±0.0	<0.001	<0.001	<0.001	<0.001
LDL-C (mmol/l)	3.6±0.1	3.3±0.0	<0.001	3.6±0.1	3.0±0.0	0.04	<0.001	<0.001	0.01
HDL-C (mmol/l)	1.4±0.0	1.4±0.0	0.74	1.3±0.0	1.3±0.0	0.81	0.02	0.12	0.38
TG/HDL	1.2±0.0	1.4±0.0	<0.001	2.1±0.0	1.4±0.0	<0.001	<0.001	0.26	<0.001
Non-HDL (mmol/l)	4.0±0.1	3.8±0.0	<0.001	3.9±0.1	3.7±0.0	<0.001	0.32	0.09	0.20
Lipo a (mg/dl)	16.9±1.2	16.1±0.7	0.55	13.4±1.2	13.8±0.7	0.81	0.04	0.02	0.28
Apo B (g/l)	1.1±0.0	1.0±0.0	0.16	1.0±0.0	1.0±0.0	0.19	0.09	0.12	0.21
Apo a1 (g/l)	1.1±0.0	1.2±0.0	0.28	1.1±0.0	1.1±0.0	0.22	0.14	0.11	0.15
Apo B/apo a1	1.0±0.0	0.9±0.0	0.11	1.0±0.0	0.9±0.0	0.31	0.79	0.28	0.73
FPG (mmol/l)	7.7±0.1	5.3±0.1	<0.001	8.6±0.1	5.4±0.1	<0.001	<0.001	0.56	<0.001
HbA1c (%)	7.7±0.1	5.6±0.0	<0.001	7.9±0.1	5.6±0.0	<0.001	<0.001	0.40	<0.001
HbA1c (mmol/mol) [#]	61	38	<0.001	63	38	<0.001	<0.001	0.40	<0.001
Insulin	2.7±0.0	2.5±0.0	<0.001	2.7±0.0	2.5±0.0	<0.001	0.41	0.75	0.66
HOMA-IR	8.6±0.5	3.7±0.3	<0.001	8.4±0.5	3.9±0.3	<0.001	0.80	0.57	0.94
TyG index	9.2±0.0	8.8±0.0	<0.001	9.4±0.0	8.8±0.0	<0.001	<0.001	0.23	<0.001
ALT	25.2±1	22.2±0.6	<0.001	30.0±1	26.4±0.6	0.28	<0.001	<0.001	0.11
VAI	3.6±0.2	2.7±0.1	<0.001	3.9±0.2	1.9±0.1	<0.001	0.19	<0.001	<0.001
LAP	58.2±1.7	53.1±1	0.01	62.2±1.8	50.7±1	0.01	0.10	0.01	<0.001
UA (mmol/l)	284.1±5.1	290.6±2.9	0.27	373.5±5.3	359.5±3.1	<0.001	<0.001	<0.001	0.81
WBC (10 ⁹ /ml)	6.9±0.1	6.2±0.1	<0.001	6.9±0.1	6.6±0.1	0.02	0.67	<0.001	0.04
Hs-CRP (mg/l)	4.9±0.5	2.7±0.3	<0.001	4.8±0.5	3.1±0.3	0.01	0.82	0.26	0.50
Ferritin (ng/ml)	150.2±12	113.0±6.9	0.01	304.3±12.5	214.4±7.2	<0.001	<0.001	<0.001	<0.001

Data are means±SEs.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

#Data are means.

WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG: triglycerides; LDL-C: low density lipoprotein cholesterol; HDL-C: high density lipoprotein cholesterol; Apo B: apolipoprotein B; Apo A1: apolipoprotein A1; FPG, fasting plasma glucose; TyG index: the product of triglycerides and fasting glucose; ALT, alanine aminotransferase; VAI: visceral adiposity index; LAP: lipid accumulation product. UA, uric acid; WBC, white blood cell count; Hs-CRP, hypersensitive C-reactive protein; PLT, platelet.

p value for difference between diabetic and non-diabetic participants

[§]Interaction of sex by diabetes status

Age-, VAI-, and HOMA-IR- adjusted mean levels of studied cardiovascular disease risk factors according to sex and HbA1c-defined diabetes status

Table 4

	Women			Men			Women vs men		
	HbA1c	6.5%	HbA1c < 6.5%	P value*	HbA1c	6.5%	HbA1c < 6.5%	P value*	P (HbA1c < 6.5%)
	P interaction [§]								
WC (cm)	89.0±0.6	87.7±0.3	132.9±0.6	0.04	90.9±0.6	90.6±0.3	0.67	0.02	<0.001
SBP (mmHg)	134.5±1.1	132.9±0.6	133.0±0.6	0.22	135.2±1.1	133.0±0.6	0.08	0.60	0.96
DBP (mmHg)	83.8±0.7	83.2±0.4	85.4±0.7	0.49	85.4±0.7	85.3±0.4	0.90	0.08	<0.001
TC (mmol/l)	5.5±0.1	5.2±0.0	5.3±0.1	<0.001	5.3±0.1	5.0±0.0	<0.001	0.04	<0.001
TG (mmol/l)	1.7±0.0	1.7±0.0	2.3±0.0	0.76	2.3±0.0	1.5±0.0	<0.001	<0.001	<0.001
LDL-C (mmol/l)	3.6±0.1	3.3±0.0	3.5±0.1	<0.001	3.5±0.1	3.0±0.0	0.06	<0.001	<0.001
HDL-C (mmol/l)	1.4±0.0	1.4±0.0	1.3±0.0	0.89	1.3±0.0	1.3±0.0	0.52	0.02	<0.001
TG/HDL	1.2±0.0	1.4±0.0	2.1±0.0	<0.001	2.1±0.0	1.4±0.0	<0.001	<0.001	0.27
Non-HDL (mmol/l)	4.0±0.1	3.8±0.0	3.9±0.1	<0.001	3.9±0.1	3.7±0.0	<0.001	0.32	0.10
Lipo a (mg/dl)	17.0±1.2	16.0±0.7	13.6±1.2	0.48	13.6±1.2	13.7±0.7	0.90	0.04	0.02
Apo B (g/l)	1.1±0.0	1.0±0.0	1.0±0.0	0.07	1.0±0.0	1.0±0.0	0.22	0.12	0.06
Apo a1 (g/l)	1.1±0.0	1.2±0.0	1.1±0.0	0.44	1.1±0.0	1.1±0.0	0.34	0.37	0.12
Apo B/apo a1	1.0±0.0	0.9±0.0	1.0±0.0	0.37	1.0±0.0	0.9±0.0	0.17	0.77	0.30
FPG (mmol/l)	7.5±0.1	5.4±0.1	8.3±0.1	<0.001	8.3±0.1	5.4±0.1	<0.001	<0.001	0.68
HbA1c (%)	7.6±0.1	5.6±0.0	7.9±0.1	<0.001	7.9±0.1	5.6±0.0	<0.001	<0.001	0.36
HbA1c (mmol/mol) [#]	60	38	63	<0.001	63	38	<0.001	<0.001	0.36
Insulin	2.6±0.0	2.6±0.0	2.5±0.0	0.93	2.5±0.0	2.5±0.0	0.74	0.39	0.38
HOMA-IR	8.6±0.5	3.7±0.3	8.4±0.5	<0.001	8.4±0.5	3.9±0.3	<0.001	0.80	0.57
TyG index	9.2±0.0	8.8±0.0	9.3±0.0	<0.001	9.3±0.0	8.7±0.0	<0.001	<0.001	<0.001
ALT	25.9±1	22.4±0.6	27.4±1.1	<0.001	27.4±1.1	26.5±0.6	0.47	<0.001	<0.001
VAI	3.5±0.2	2.7±0.1	3.8±0.2	<0.001	3.8±0.2	2.0±0.1	<0.001	0.19	<0.001
LAP	57.4±1.7	53.4±1	58.4±1.8	0.05	58.4±1.8	51.9±1	0.03	0.10	0.01
UA (mmol/l)	282.1±5.1	291.3±2.9	351.7±5.3	0.12	351.7±5.3	380.1±3.1	<0.001	<0.001	<0.001
WBC (10 ⁹ /ml)	6.9±0.1	6.2±0.1	6.8±0.1	<0.001	6.8±0.1	6.6±0.1	0.07	0.68	<0.001
Hs-CRP (mg/l)	4.6±0.5	2.8±0.3	4.5±0.5	<0.001	4.5±0.5	3.2±0.3	0.03	0.83	0.28
Ferritin (ng/ml)	147.5±12.2	114.0±6.9	301.8±12.6	0.02	301.8±12.6	215.2±7.2	<0.001	<0.001	<0.001

Data are means±SEs.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

#Data are means.

WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglycerides; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; Apo B: apolipoprotein B; Apo A1: apolipoprotein A1; FPG, fasting plasma glucose; TyG index: the product of triglycerides and fasting glucose; ALT, alanine aminotransferase; VAI: visceral adiposity index; LAP: lipid accumulation product; UA, uric acid; WBC, white blood cell count; Hs-CRP, hypersensitive C-reactive protein; PLT, platelet.

* p value for difference between diabetic and non-diabetic participants

[§]Interaction of sex by diabetes status