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Change in general and central adiposity measures in prediction of incident dysglycemia; Tehran Lipid and Glucose Study

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ABSTRACT

Objectives. To examine the change in general and central adiposity measures as a predictor of incident dysglycemia during a 6-year follow-up.

Subjects. A total of 4029 (2333 women and 1696 men) non-dysglycemic Iranians aged ≥20 years, underwent standard fasting and 2-h post-challenge plasma glucose tests at baseline and follow-up.

Results. During follow-up, 458 new cases of dysglycemia occurred. In multivariable models including baseline values of each anthropometric measure, odds ratios (ORs) for dysglycemia incidence corresponding to a 1-SD increase in changes of body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) and hip circumference (HC), were 1.32, 1.56, 1.39, 1.51 and 1.39 for men and 1.59, 1.50, 1.37, 1.47, and 1.38, for women, respectively (all $P<0.05$). After controlling for weight change and WC change among men and women, respectively, HC change did not remain as a predictor. Using the paired homogeneity test, there was no superiority for changes in central obesity measures compared to changes in BMI to predict dysglycemia.

Conclusion. The association between HC changes and incident dysglycemia was dependent upon changes in central and general adiposity measures, where the former did not have higher predictability than the latter in prediction of dysglycemia.

Introduction

The prevalence of obesity is escalating worldwide (Finucane et al., 2011), imposing metabolic and cardiovascular burdens especially in developing countries (Farzadfar et al., 2011). The association between obesity and incident diabetes has already been demonstrated in several studies (Abdullah et al., 2010; Hadaegh et al., 2011; Lee et al., 2004). However, the association between weight change and incident diabetes is not consistent. Most studies reported positive association between weight change and incident diabetes (Ford et al., 1997; Oguma et al., 2005) however, Mishra et al. showed that women' risk of developing diabetes in midlife is more closely attributed to their initial weight than to following short-term weight change (Jacobs-van der Bruggen et al., 2010; Mishra et al., 2007). Recently, Jacobs-van der Bruggen et al. (2010) showed that weight change appears to have no effect on diabetes incidence beyond its effects on attained body mass index (BMI) ().

Baseline measurement of general and central adiposity measures found to be positively associated with incident diabetes and impaired glucose tolerance in prospective studies (Vazquez et al., 2007). In contrast, adverse metabolic effects of a small hip size were consistent after controlling for general adiposity or for waist circumference (Heitmann and Lissner, 2011). Besides studies that show a protective nature of large hip girth for metabolic disorders, some studies that considered changes in hip circumference show different results which do not strongly support this concept (Asghar et al., 2011; Koh-Banerjee et al., 2004).

The aim of this study is to examine the association between changes in general and central adiposity measures and in hip circumference as well as incident impaired glucose metabolism, in a Middle Eastern community-based cohort of the Tehran Lipid and Glucose Study (TLGS). In addition, we examined if there is no superiority between changes of general adiposity measures versus that of central adiposity measures in prediction of incident dysglycemia.

Materials and methods

Study subjects

The TLGS is an ongoing prospective study aimed at determining the risk factors and outcomes for non-communicable disease being conducted on a

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representative sample of 15,005 residents of district-13 of Tehran, aged 3 years and over (Azizi et al., 2009). Subjects were categorized into the cohort and intervention groups, the latter to be educated for implementation of lifestyle changes. Educational context included methods and benefits of improving nutrition and dietary pattern, increasing physical activity levels, and reducing cigarette smoking (Harati et al., 2010). As designed in TLGS protocol, the whole population was followed up in several phases, phase I (cross-sectional phase of TLGS) in 1999–2001, phase II in 2002– 2005 and phase III in 2006–2008, at about 3.6-year intervals. Of the 15,005 population, 10,368 subjects, aged ≥20 years were examined in phase 1 TLGS; and those with prevalent dysglycemia at baseline (using glucose-lowering drugs or having impaired glucose tolerance or type 2 diabetes) were excluded, leaving 7188 subjects; after further exclusion of those with missing anthropometric data at baseline and follow-up visits ($n=2763$) and those with outlier changes in anthropometric measures (≥3 SD away from the mean) ($n=396$), 4029 subjects (2333 women, 1696 men) were monitored for a mean follow-up period of 6.6 years (phase III of TLGS) (Fig. 1). Written informed consent was obtained from all subjects and the ethical committee of Research Institute for Endocrine Sciences approved this study.

Clinical and laboratory measurements

Data collection methodology has been described concisely elsewhere (Azizi et al., 2009). Briefly, a trained interviewer collected the subjects' demographic data; and also measured their body weight, height, waist circumference (WC) and hip circumference (HC) using standard methods.

The measurements of blood glucose, triglyceride (TG) and high-density lipoprotein cholesterol (HDL-C) levels were all done after 12-to 14-h overnight fasting. TG/HDL-C value was computed by dividing serum triglyceride concentration by the HDL-C value.

The standard oral glucose tolerance test (OGTT) was performed for all participants not on glucose-lowering drugs.

Fasting serum insulin was determined by the electrochemiluminescence immunoasaay method using Roche Diagnostic's kit (GmbH, Mannheim, Germany) and Roche/Hitachi Cobas e-411 analyzer (GmbH, Mannheim, Germany). Insulin concentrations were acquired in μIU/ml; and converted to the SI unit (pmol/l) by the multiplication factor of 6.945, as recommended in the assay instructions.

Definition of terms

Participants with fasting plasma glucose (FPG≥7 mmol/l, or 2-h post-challenge plasma glucose(2hPG)≥11.1 mmol/l or those who used anti-diabetic drugs were defined as diabetic; participants with 2-h post-challenge plasma glucose≥7.8 mmol/l and <11.1 mmol/l were considered as having impaired glucose tolerance (IGT) (American Diabetes Association, 2011). Dysglycemia was defined as the presence of IGT or diabetes.

Hypertension was defined as any regular or irregular usage of any blood pressure-lowering drug or systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg as measured at the baseline visit (Carretero and Oparil, 2000).

Statistical analysis

We used Spearman's correlation coefficient to assess the correlation between any changes of anthropometric measures. To examine the association between main exposures and other potential confounder variables, linear regression model analysis was applied.

To investigate the association between each absolute change in anthropometric measures and incident dysglycemia, we ran binary logistic regression analysis with subjects' final dysglycemia status regarded as outcome variable and the natural logarithm of follow-up time as the offset variable. We selected candidate covariates based on both statistical and scientific evidence.

We designed four models. Model 1: unadjusted, model 2: univariable model adjusted for confounding variables (subjects' age, diabetes family history, history of gestational diabetes mellitus or macrosomia, history of cardiovascular disease, smoking status, educational level and their intervention participation status), model 3: model 2 variables further adjusted for other confounders; baseline measures of FPG, 2hPG, TG/HDL-C and their baseline hypertensive status, model 4: variables in model 3 further adjusted for the baseline value of the studied anthropometric measure. In cases of hip circumference changes, we additionally adjusted the final model (model 4) for waist circumference and weight changes; and in case of waist circumference change, we also adjusted the model 4 for hip circumference change. We performed a paired homogeneity test, which is a Wald test of the linear hypothesis of the logistic model regression coefficients to test the null hypothesis that the odds ratios (ORs) for BMI change were equal to that for WC change, or WHR change or WHtR change in prediction of incident dysglycemia. For the paired homogeneity test, BMI change and one of the central obesity measures were entered simultaneously in the same logistic model, considering covariates reported in model 2 for men and women (Stiger et al., 1999). Collinearity of the anthropometrics changes was assessed using variance inflation factor (VIF) before placing them into a single model (Mansfield and Helms, 1982).

We performed all analyses using STATA, version 10. Significance cutoff was set at the level of 0.05 for all analyses.

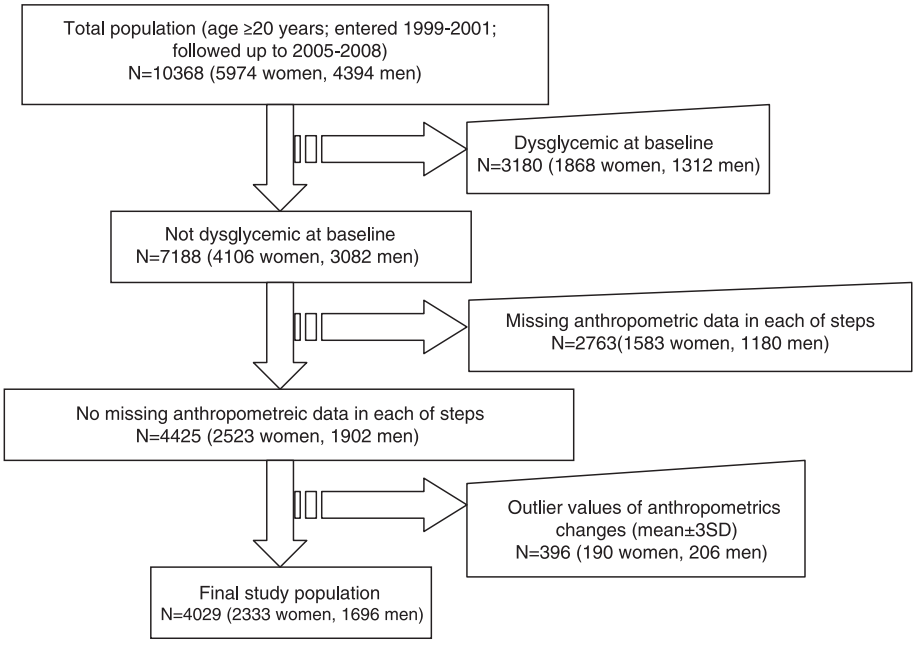

Fig. 1. Study population selection flowchart in Tehran Lipid and Glucose Study (TLGS), Iran, 2001–2011.