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Original Research

The Visceral Adiposity Index in Comparison with Easily Measurable Anthropometric Markers Did Not Improve Prediction of Diabetes

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ABSTRACT

Objectives: We evaluated the ability of the visceral adiposity index (VAI) compared to hypertriglyceridemic-waist (HTGW) phenotype, body mass index (BMI), waist circumference (WC), waist-to-height ratio (WHtR) and waist-to-hip ratio (WHR) as a possible predictor of diabetes in a nondiabetic high-risk population.
Methods: We analyzed 7-year follow-up data in nondiabetic first-degree relatives of consecutive patients 30 to 70 years of age with type 2 diabetes and with at least 1 follow-up examination (N=1720). The primary outcome was the diagnosis of type 2 diabetes based on repeated oral glucose tolerance tests. We examined the incidence of type 2 diabetes across quintiles of the VAI and plotted a receiver operating characteristic (ROC) curve to compare the abilities of predicting type 2 diabetes of the VAI, BMI, WC, WHR and WHtR.
Results: The highest quintile of VAI compared with the lowest quintile was associated with type 2 diabetes in age- and gender-adjusted models (OR 2.45; 95% CI 1.56, 3.86). Those with the HTGW phenotype were 2.36 times (OR 2.36; 95% CI: 161, 3.44) more likely to develop type 2 diabetes than those with normal WCs and normal triglyceride levels. On ROC curve analysis, almost similar areas under the ROC were found for BMIs (60.9%; 95% CI: 57.1, 64.6); WC (61.0%, 95% CI 57.4, 64.5); WHtR (62.6%; 95% CI: 59.1, 66.2); WHR (55.7%; 95% CI 52.2, 59.3) and VAI (58.3%; 95% CI: 54.5, 62.1).
Conclusions: These data provide further evidence that VAI and HTGW are robust predictors of type 2 diabetes, but the predictive power was similar to that of BMI, WC, WHtR and WHR in our study population.

Mots clés :
parents de premier degré
taille hypertriglycéridémiante
facteur de risque
incidence du diabète de type 2
indice d'adiposité viscérale

RÉSUMÉ

Objectifs : Nous avons évalué la capacité potentielle de l'indice d'adiposité viscérale (IAV) par rapport au phénotype de taille hypertriglycéridémiante (THTG), à l'indice de masse corporelle (IMC), au tour de taille (TT), au rapport tour de taille/taille (RTTT) et au rapport taille/hanches (RTH) à prédire le diabète chez la population non diabétique exposée à un risque élevé.
Méthodes : Nous avons analysé les données du suivi de 7 ans de parents non diabétiques de premier degré de patients consécutifs de 30 à 70 ans souffrant du diabète de type 2 et ayant eu au moins 1 examen de suivi (N=1720). Le critère de jugement principal était le diagnostic du diabète de type 2 fondé sur les épreuves répétées d'hyperglycémie provoquée par voie orale. Nous avons examiné l'incidence du diabète de type 2 dans tous les quintiles de l'IAV et tracé une courbe caractéristique d'efficacité du récepteur (ROC) pour comparer les capacités de l'IAV, de l'IMC, du TT, du RTH et du RTTT à prédire le diabète de type 2.
Résultats : Le quintile le plus élevé comparativement au quintile le plus bas de l'IAV était associé au diabète de type 2 dans les modèles ajustés selon l'âge et le sexe (RIA 2,45; IC à 95% : 1,56, 3,86). Ceux du phénotype de THTG étaient 2,36 fois (RIA 2,36; IC à 95% : 161, 3,44) plus susceptibles de développer le diabète de type 2 que ceux ayant des TT normaux et des concentrations normales de triglycérides. À l'analyse de la courbe ROC, des surfaces sous la courbe ROC presque similaires étaient observées pour les IMC (60,9%; IC à 95% : 57,1, 64,6); le TT (61,0%, IC à 95% : 57,4, 64,5); le RTTT (62,6%; IC à 95% : 59,1, 66,2); le RTH (55,7%; IC à 95% : 52,2, 59,3) et l'IAV (58,3%; IC à 95% : 54,5, 62,1).

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Conclusions : Ces données fournissent une preuve supplémentaire que l'IAV et la THTG sont des prédicteurs fiables du diabète de type 2, qui ont un pouvoir prédictif similaire à celui de l'IMC, le TT, le RTTT et le RTH de notre population faisant l'objet de l'étude.

Introduction

It is well established that obesity, particularly abdominal obesity, is a strong risk factor for type 2 diabetes, and measuring waist circumference (WC) is an effective tool for screening individuals at high-risk for type 2 diabetes (1,2). Excess abdominal fat may lead to insulin resistance and abnormal glucose metabolism (3,4). However, obesity is remarkably heterogeneous; some obese individuals never develop type 2 diabetes (5). Nevertheless, because WC cannot fully discriminate between visceral and subcutaneous fat, visceral lipid accumulation, which is defined as the visceral adiposity index (VAI), a mathematic model that combines WC, body mass index (BMI), triglyceride levels (TG) and high-density lipoprotein cholesterol (HDLC) levels (6), hypertriglyceridemic-waist (HTGW) phenotype (a combination of abdominal obesity and elevated fasting TG (7)) and lipid accumulation product (a combination of WC and TG (8,9)) has been established to distinguish visceral fat from subcutaneous fat. Although magnetic resonance imaging and computed tomography are the gold standards for measuring visceral fat, they are not suitable for epidemiologic studies and daily practice for practical, ethical and economic reasons. The clinical utility of the VAI to identify individuals with both cardiovascular and cerebrovascular disease was first reported by Amato et al (6). Their results have been replicated for predicting insulin sensitivity (10), glycemic disturbances (11) and type 2 diabetes (12). The VAI was associated with visceral fat tissue but not with subcutaneous fat tissue in obese and overweight postmenopausal women (13). The VAI is also a reliable marker of visceral fat function associated with cardiometabolic risk (6) and metabolic syndrome (13). Only a few studies have examined the association between the VAI and the risk for type 2 diabetes and compared it to various body fatness indexes, and they came to inconsistent conclusions (12,14–17); its discriminatory power was not better than other anthropometric indexes in identifying the risk for type 2 diabetes in some (14–16) but not all (12,17) studies. In Chinese cross-sectional (12,16) and cohort (15,17) studies and in the Tehran Lipid and Glucose cohort (14) study, the VAI was associated with increased risk for type 2 diabetes. However, the ability of VAI to identify type 2 diabetes risk was not found to be superior to easily measurable anthropometric markers, such as BMI, WC, waist-to-height ratio (WHtR) (14–16). The clinical usefulness of the VAI in predicting type 2 diabetes has not been explored among Iranian first-degree relatives (FDRs) of patients with type 2 diabetes, who are known to have a high prevalence of prediabetes and type 2 diabetes (18).

The objective of this ongoing longitudinal study, therefore, was to explore the clinical usefulness of the VAI in predicting the incidence of type 2 diabetes in an Iranian nondiabetic high-risk population and to compare the predictive ability of the VAI, HTGW and other anthropometric indexes. We hypothesized that the VAI would predict type 2 diabetes better than the HTGW and the other anthropometric markers in a high-risk population.

Methods

Data collection

This study was conducted within the framework of the Isfahan Diabetes Prevention Study (IDPS), which has been described in detail elsewhere (19). In brief, IDPS, initiated in 2003, is an ongoing cohort in central Iran established to assess the various potential risk factors for diabetes in subjects with family histories of type 2 diabetes (1 of the main risk factors for diabetes). Our study sample at baseline comprised 3483 (919 men and 2564 women) FDRs of consecutive patients with type 2 diabetes. All patients were attendees at clinics at Isfahan Endocrine and Metabolism Research Center, which is affiliated with Isfahan University of Medical Sciences, Iran. The study was conducted between the years 2003 and 2005. All participants were from Isfahan city and adjoining areas. They completed laboratory tests, including standard 75 g 2-hour oral glucose tolerance tests (OGTTs), fasting serum lipid profiles and questionnaires concerning their health statuses and various potential risk factors for diabetes. Participants received follow-up tests according to Standard of Medical Care in Diabetes (20) to update information on demographic, anthropometric and lifestyle factors and on newly diagnosed diabetes. Accordingly, if OGTTs at baseline were normal, repeat testing was carried out at least at 3-year intervals. Otherwise, repeat testing was usually carried out annually.

Ethics statement

This study approved by the Isfahan University of Medical Sciences ethical committee, and an informed consent form was signed by each participant.

Follow up and ascertainment of type 2 diabetes

Of the 3483 persons who participated at baseline, 329 subjects were excluded because of diagnosis of type 2 diabetes at baseline, 1285 did not attend any follow-up examinations and 149 had missing data on TG and/or HDLC at baseline, leaving 1720 participants with a mean age of 43.0 (6.5) (range 30 to 70) years for this analysis, all of whom had at least 1 subsequent review during a mean (SD) follow-up period of 7.3 (2.2) (range, 1 to 10) years. Pregnant women were excluded.

Clinical and laboratory measurements

Information about ages, gender, body sizes, glycated hemoglobin (A1C), total cholesterol (TC), low-density lipoprotein cholesterol (LDLC), HDLC, TG and blood pressure (BP) levels and family and personal medical histories was collected at baseline and throughout follow ups. The same methodology was used for baseline and follow-up studies. The participants included siblings and children of patients with type 2 diabetes. Participants reported to clinics in the morning after an overnight fast. They were asked to abstain from vigorous exercise in the evening and in the morning of their visit. Smokers were encouraged to abstain from smoking in the morning of the investigations. First, on arrival at the clinic, the information provided by the participants in the questionnaire on family history was verified. Then, with the subjects in light clothing and without shoes, height, weight, WC and hip circumference (HC) were measured using standard apparatus and recorded to the nearest 0.1 kg and 0.5 cm, respectively. The WC was measured midway between the lower rib margin and the iliac crest at the end of gentle expiration in the standing position. Hip circumference was measured over the greater trochanters directly over the underwear. The BMIs were calculated as the weight in kg divided by square of the height in meters. Resting BP was measured at each examination by physicians, with the participants in a sitting position after