Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation

Association of abdominal fat with serum amylase in an older cohort: The Baltimore Longitudinal Study of Aging

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ARTICLE INFO

Article history:
Received 11 December 2015
Accepted 16 April 2016
Available online 26 April 2016

Keywords:
Abdominal visceral/subcutaneous fat
Aging
Diabetes
Serum amylase

ABSTRACT

Aims: Abdominal fat is a major determinant of metabolic diseases in older individuals. Obesity and diabetes are associated with low serum amylase (SA) levels, but the association between SA and metabolic disease is poorly understood. We investigated the association of low SA with diabetes and sex-specific associations of serum amylase with abdominal fat in older adults.

Methods: In community-dwelling volunteers from the Baltimore Longitudinal Study of Aging (778 participants, age 66.8 ± 13.6 years), we assessed abdominal fat by computed tomography and diabetes status using the American Diabetes Association criteria. Linear regression analyses assessed the cross-sectional associations between abdominal fat and SA, and logistic regression assessed the odds of diabetes, given low SA.

Results: In unadjusted analyses, individuals in the lowest SA quartile (<48 μ/L) had 1.97 greater odds of diabetes, (95%CI, 1.01–3.83) than those in the highest quartile (⩾80 μ/L). This association was no longer significant after adjusting for visceral adipose tissue area (VAT, dm^2), abdominal subcutaneous adipose tissue (SAT, dm^2) or BMI. In adjusted analyses, VAT and SAT were significantly associated with SA in both sexes. Among women, SA was more strongly associated with VAT than with SAT or BMI; VAT ($\beta = -0.117 \pm 0.048$, $P < 0.001$), SAT ($\beta = -0.023 \pm 0.025$, $P = 0.346$) and BMI ($\beta = -0.0052 \pm 0.075$, $P = 0.49$).

Conclusions: The association between SA and diabetes was explained mainly by abdominal visceral fat. In women, SA was more strongly associated with VAT than with BMI or SAT. These findings provide motivation for future mechanistic studies on SA's role in metabolic diseases.

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1. Introduction

Recently, much interest has been drawn to the association between amylase and obesity, most particularly salivary amylase, as low copies of salivary amylase gene expression predict obesity in humans [1,2]. Amylase is a glycoside hydrolase, which acts upon the bonds between the glucose units of the starch polymers, contributing to carbohydrate

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http://dx.doi.org/10.1016/j.diabres.2016.04.015
0168-8227/Published by Elsevier Ireland Ltd.

digestion [3]. In healthy individuals, the pancreas and the salivary glands account for almost all serum amylase; it is estimated that between 40% and 45% comes from the pancreas and 55–60% from the salivary glands [4]. A series of human studies in Asians has reported an association between the prevalence of low serum amylase and increases in diabetes and metabolic syndrome [5], and low serum amylase has been linked with diabetes and obesity [5,6].

Excessive intake of refined carbohydrates plays a role in the development of obesity and type 2 diabetes [7,8]. As the prevalence of obesity increases worldwide, scientists and pharmaceutical companies are investigating ways to reduce body weight and prevent weight gain. Some claim that amylase inhibitors known as starch blockers, which are extracted from certain food plants such as kidney beans and wheat, inhibit salivary and pancreatic activity and reduce absorption of starches in the small intestine, leading to weight loss and reduced blood glucose [9]. However, when starch blockers were first developed, researchers did not find them effective for limiting carbohydrate absorption, and the evidence for weight loss is still unclear [10]. In addition, the molecular mechanism underlying the associations among serum amylase, diabetes and obesity is unknown. Epidemiological studies investigating the relationship between serum amylase and diabetes or obesity are few. To better understand the role of amylase in metabolic diseases such as diabetes and obesity with the goal of creating more effective treatments to reduce blood glucose, more epidemiological and intervention studies are needed.

Given the substantial literature showing that abdominal obesity, specifically visceral adiposity, increases the risk of type 2 diabetes and metabolic syndrome [11–14], the large proportion of older individuals who suffer from metabolic diseases, and the paucity of studies on serum amylase, examining the link between serum amylase and abdominal adiposity may fill an important evidence gap. Therefore, the purpose of this study is to investigate the associations of serum amylase with diabetes and with measures of body fat focusing on abdominal obesity.

2. Subjects, materials, and methods

2.1. Study subjects

The BLSA is a study of normative human aging, established in 1958 and supported by the National Institute on Aging Intramural Research Program (NIA – IRP). General descriptions of the sample and the enrollment procedures and criteria have been reported [15]. Briefly, the BLSA constitutes a continuously enrolled cohort with some targeted recruitment (e.g., women, racial minorities) over its 57-plus year history. All participants are community volunteers who must pass a comprehensive health and functional screening evaluation and be free of all major chronic conditions and cognitive and functional impairment at enrollment. Once enrolled, participants undergo extensive testing every one to four years depending on their age and are followed for life. The population for the current study consists of 778 participants seen in the BLSA clinic between April 2003 and June 2012. The NIH NIEHS IRB (National Institute of Environmental Health Sciences) approved the study protocol and all participants provided written informed consent.

2.2. Measures

2.2.1. Anthropometric and biochemical measurements

Stature was measured to the nearest 0.1 cm by Stadiometer from (Holtain Limited, Crymych, Dyfed, UK) and body weight was measured to the nearest 0.1 kg by using SR scale model 725 L from (SR Instruments, Tonawanda, NY, US) to calculate body mass index (BMI). Total body muscle mass and fat were measured using dual-energy X-ray absorptiometry (DEXA) (Lunar prodigy 10190 and prodigy advance PA + 130024 from GE Healthcare, Madison, WI, US). All DEXA scans were analyzed using Encore 2006 software version 10.51.006 from (GE Healthcare, Madison, WI, US) for body composition analysis.

2.2.2. Diabetes definition

Diabetes was defined as fasting plasma glucose $\geqslant$ 126 mg/dL, consistent with the 2015 American Diabetes Association criteria [16]. In the BLSA sample, 9.3% of women and 13% of men satisfy this definition. Using this criteria, our definition of person with diabetes was limited to those with uncontrolled fasting blood glucose, regardless of medication status, as individuals with diabetes who are not well-controlled are likely to be metabolically different than those who are well-controlled [17,18].

2.2.3. Serum amylase measurement

Serum amylase levels were measured using an automatic biochemistry and immunoassay analyzer/integrated system Dimension Vista 3000T (Siemens Healthcare, Malvern, PA). The intra and inter-assay coefficient of variation (CV) for the amylase was less than 5%.

2.2.4. CT-abdomen quantification

A cross-sectional 10 mm CT image of the abdomen was obtained from each participant at the lumbar spine level (L4-L5) using a Somatom Sensation 10, multislice, helical CT Scanner (Siemens Healthcare, Malvern, PA). Abdominal VAT (visceral adipose tissue area) and abdominal SAT (subcutaneous adipose tissue area) were extracted from the total cross-sectional area of the abdomen, and Geanie software version 2.1 (BonAlyse Oy, Jyvaskyla, Finland) was used to quantify the cross-sectional area (dm^2).

2.2.5. Other covariates

The study included men and women. Age and ethnicity were ascertained by self-report, with ethnicity categorized as White, Black or other.

2.3. Statistical analysis

All statistical analyses were performed using SAS version 9.3 software. Amylase levels that were not normally distributed were logarithmically transformed before analysis: however, mean values of the variables are presented untransformed as mean ± SD for descriptive purposes (Table 1). Unpaired t-tests and chi-square test were used to compare participant characteristics differences by sex (Table 1). Logistic regression was used to estimate the odds ratio of prevalent diabetes by