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Research paper

The relationship between visceral adiposity and depressive symptoms in the general Korean population

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ABSTRACT

Background: In Korea, depressive symptoms or depression are prevalent. Metabolic syndrome is the representative medical condition associated with depression. This study examined the association between clinically significant depressive symptoms and intra-abdominal fat, measured using abdominal computed tomography, in a large sample of the Korean population who underwent routine health examination.

Methods: People who underwent routine health examinations at the Seoul National University Hospital Healthcare System, Gangnam Center, from October 2004 to July 2012 were included in the study. There were 11,434 cases of individuals with CT scan data and entries in the Beck Depression Inventory (BDI). Of these, 1156 men and women underwent CT scans more than once. In these cases, we analyzed the first scan.

Results: We analyzed 4945 male and 2293 female participants; 333 participants (171 male, 162 female) were in the clinically depressed group. After controlling for confounding factors, we found that clinically depressive symptoms were associated with visceral adiposity in women. Per 1 cm^2 of visceral adipose tissue area, the risk of being clinically depressed increased 1.006-fold. Similarly, per 1% increase in the ratio of visceral and total adipose tissue area in women, the risk increased 1.028-fold.

Conclusions: Our large-sample study showed depressive symptoms are associated with intra-abdominal fat and the ratio of visceral and total adipose area in women, after controlling for confounding factors including BMI, hypertension, and diabetes.

1. Introduction

In Korea, depressive symptoms or depression are prevalent psychiatric diseases. For depression, an annual point prevalence rate and a lifetime prevalence rate are 2.5% and 5.6% (Cho et al., 2010). Subsequently, the increasing prevalence of depression will raise the problem of disease burden over time (Cho et al., 2010; Lépine and Briley, 2011). Many investigators consider depression or depressive symptoms as an output of another disease (Kim et al., 2015; Morrison et al., 2015; Phillips, 2011). The need for a more comprehensive analysis of depression has led investigators to record the evidences of associations between depression and more well-defined disease classifications, such as the general medical condition (Vaccarino et al., 2008; Windle and Windle, 2013).

In particular, metabolic syndrome is the representative medical condition associated with depression (Grundy, 2004). A previous meta-analysis showed that depression and metabolic syndrome, which includes a cluster of cardiovascular disease risk factors such as abdominal obesity, high triglyceride (TG) levels, low high-density lipoprotein cholesterol (HDL) levels, high blood pressure, and high glucose levels, are mutually associated (Pan et al., 2012). In contrast, other studies have been unable to show the association between the two conditions

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(Herva et al., 2006; Hildrum et al., 2009). Furthermore, a few investigators speculate that the sex of an individual may contribute to this association, and should therefore be investigated (Gil et al., 2006; Kinder et al., 2004; Laudisio et al., 2009; Marcellini et al., 2009; Nishina et al., 2011; Pulkki-Råback et al., 2009; Toker et al., 2008). Our team has analyzed the association between subjective depressive symptoms and metabolic syndrome, and in our previous study, we have shown that subjective depressive symptoms are associated with metabolic syndrome in women (Rhee et al., 2014). Some studies showed that the intersection of ethnicity, sex, and age might influence the association between Body Mass Index (BMI) and depressive symptoms (Assari, 2014a, 2016, 2014b; Assari, 2016; Assari et al., 2017). Another study has also found that lipid profiles are associated with both obesity and insulin resistance (Grundy, 2004).

Due to such results, many investigators have become interested in studying obesity among the factors associated with metabolic syndrome (Merikangas et al., 2012). Waist circumference has been previously investigated in a study, in which authors could not prove the association between waist circumference and mental disorders from an epidemiologic perspective (Hach et al., 2006). A Korean study showed that women with general obesity were less likely to have depressive symptoms and women with abdominal obesity by waist circumference were less likely to have depressive symptoms in middle age (Yim et al., 2017). Another commonly used surrogate measure of adiposity is a direct measure of visceral and subcutaneous adipose tissue by computed tomography (CT). Intra-abdominal fat deposition was found to have increased in patients with major depressive illness, as measured by CT; however, the study was conducted in a small number of participants (Thakore et al., 1997). A subsequent study found that insulin resistance, as well as visceral fat was related to depressive symptoms; however, the participants only consisted of middle-aged men (Yamamoto et al., 2016). Depressive symptoms were found to be associated with visceral adiposity only in women in a community-based sample study, although participants were confined to the middle-aged group in this study (Murabito et al., 2013). Another study failed to show the association between depressive symptoms and increased levels of visceral fat in a sample of 409 middle-aged women (Everson-Rose et al., 2009).

Our study examines the association between clinically significant depressive symptoms and intra-abdominal fat in a large sample of the general Korean population. Participants include people that participated in a health screening program. We hypothesize that depressive symptoms and intra-abdominal fat are mutually associated and a sex-dependent differentiation exists in this association. To test the hypotheses, we investigated the cross-sectional association between intra-abdominal fat measured with abdominal CT and subjective depressive symptoms measured using the Beck Depressive Inventory (BDI), BMI, and other factors, such as diabetes and hypertension.

2. Methods

2.1. Study sample

Individuals who underwent routine health examinations at the Seoul National University Hospital Healthcare System, Gangnam Center, from October 2004 to July 2012 were included in our study. These examinations are performed to screen for and enable early diagnoses of certain diseases and are available to all individuals who pay fees. The center has various options of routine health examinations that each individual can choose from. There were 11,434 cases of individuals who underwent at least one CT scan and were included in the Beck Depression Inventory-1 (BDI). Of these, 1156 cases, that included men and women, underwent a CT scan more than once. In these cases, we analyzed the first CT scan, along with results from the BDI.

2.2. Assessment of subjective depressive symptoms

The severity of subjective symptoms was assessed using BDI, a 21-item self-report questionnaire that scores each question from 0 to 3 points (Beck et al., 1961). A threshold of 21 points was initially proposed for the Korean population (Hahn, 1982). A threshold of 19 points was proposed for moderate depression (Beck et al., 1988). Despite pre-existing demarcations, different threshold points have been used in the literature to indicate depressive symptoms in metabolic studies (Marijnissen et al., 2013; Miettola et al., 2008). A majority of subsequent studies have used 16 points as the cutoff for clinical depression (Jo et al., 2007; Lee, 1991; Shin et al., 1993). In a previous metabolic study, our team also classified patients with a total BDI score ≥ 16 as having clinical depressive symptoms (Rhee et al., 2014). We have applied the same cutoff in this study as well.

2.3. Assessment of confounding risk factors

Participants' weight and height were measured while they were wearing light clothing. BMI was calculated as weight (kg) divided by the square of the participant's height (m^2). Hypertension was defined as systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg, or the use of antihypertensive medication based on the WHO guidelines for the management of hypertension (WHO, 2000). Diabetes was defined based on current treatment with insulin or oral hypoglycemic medication, or 8-h fasting plasma glucose ≥ 126 mg/dL, as recommended by the American Diabetes Association (Kahn, 2003).

Structured questionnaires were used to collect information on demographic variables such as age, marriage status, cigarette use, alcohol use, exercise, education, previously diagnosed diseases, and current medication.

2.4. Assessment of visceral adipose tissue area

The technique used for adipose tissue area measurements in CT cross-sectional images has been reported in previous studies (Chung et al., 2008; Yoon et al., 2012). Results have negligible inter-observer variation (Thaete et al., 1995).

The study protocol was reviewed and approved by the institutional review board in Seoul National University Hospital.

2.5. Statistical analyses

Differences in demographic and metabolic characteristics between participants, with or without depressive symptoms, were assessed based on the cutoff value of the BDI score, above or equal to 16 points. Continuous variables were analyzed with Student's *t*-test and categorical variables were analyzed with *chi*-square test or Fisher's exact test, to measure between-group comparisons.

Multiple logistic regression models were used to evaluate the association between depressive symptoms and visceral adipose tissue area after adjusting potential confounders; sex, age, BMI, total abdominal fat, Hypertension (HTN) and Diabetes Mellitus (DM). First, we tested the interaction between sex and visceral adipose tissue area in the multiple logistic regression model. Since the interaction was significant ($p < 0.001$), we analyzed for each sex, separately. For further analysis, we also tested the effect the ratio of visceral to total (visceral and subcutaneous) fat area on depressive symptom adjusting sex, age, BMI, visceral and total abdominal fat, HTN and DM if there is the significant relation between visceral adipose tissue area and depressive symptom. We also performed bivariate correlation analyses. Statistical significance was defined as $p < 0.05$. Statistical analyses were performed with SPSS 21.0 (SPSS, Inc., Chicago, IL).

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