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The effect of visceral fat and elevated blood glucose on anxiety levels in college age students

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ABSTRACT

Anxiety is prevalent among young adults; research shows metabolic inflexibility, the inability to oxidize fat, can increase the occurrence of hyper-aroused states. Fasting blood glucose is the current protocol for assessing metabolic impairment. However, recent studies have shown young adults may have normal fasting blood glucose levels with underlying irregularities in postprandial glucose regulation, insulin secretion and cortisol release, which causes a pattern of visceral fat accumulation. Visceral fat of the volunteers was assessed using the DXA (Dual-energy X-ray absorptiometry) full body scanning method; the waist was assessed by taking the circumference at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest to formulate a waist to height ratio (WHtR); fasting glucose levels were measured via point-of-care (POC) finger-stick method using the Abbott Precision blood glucose meter and anxiety levels. The Pearson R correlation test showed significance between GAD-7 and VAT Volume at r = 0.513 VAT Mass r = 0.514 body fat percentage r = 0.407 and Android r = 0.419. This correlation between GAD-7 and VAT Volume and VAT Mass shows the physiological connection between elevated visceral fat and heightened anxiety. High amounts of visceral fat may lead to an increase in insulin and cortisol levels. The study may suggest that increased fasting blood glucose is not necessarily the best predictor of metabolic dysregulation in a population of healthy college students.

1. Introduction

Children born at the end of the 20th century and/or the beginning of the 21 st century are predicted to be the first generation to not outlive their parents due to the effects of obesity and metabolic impairments [1]. The current protocol to assess for metabolic risk is fasting blood glucose (FBG). Elevations in fasting blood sugar (>100 mg/dL) may indicate metabolic impairment including a sympathetic medullary response. The consequences of over-releasing insulin are postprandial hypoglycemia, metabolic inflexibility and the chronic secretion of sympathetic "fight or flight" hormones, primarily cortisol. Cortisol may "rescue" dips in blood elevated body fat in the American population costs between $48 and $68 billion per year in medical related expenses; excess body fat greatly increases the risk for diabetes, stroke, cardiovascular disease and cancer. Elevation of visceral fat and unstable blood sugar have been shown to increase cortisol levels. Elevated cortisol may contribute to anxiety via chronic stimulation of the HPA axis. Anxiety is often a precursor to depressive symptoms; both anxiety and depression may be early indicators of metabolic instability [2]. 6.8 million adults suffer from anxiety disorders in the United States. Each year, more and more young are prescribed anti-anxiety medications; many of the most commonly prescribed young adults at an increased risk suicide. While there has been research to correlate body fat with depressive/anxious symptoms, there has not been significant research conducted to correlate levels of visceral fat storage, fasting blood glucose and anxiety levels as measured by the GAD-7 with a healthy college population large increases in obesity and metabolic dysregulation. The goal of this research is to determine if anxiety levels are correlated with visceral fat storage, even in the presence of sugar via the stress-mediated release of glycogen from the liver. Increasing trends in unstable blood sugar, along with normal fasting blood glucose, within a population of healthy college students.

2. Methods

The Institutional Review Board at Bethel University approved all methods and procedures for the study. Twenty- seven Bethel college students ages 18–25 (n = 27, male = 16, female = 11 were recruited for this study. The participants were contacted through personal emails and those that agree to participate

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were informed to fast for 9–12 hours prior to testing. Study details were provided at a mandatory information session prior to testing. subjects were given all information related to the research using a written informed consent form based on the Bethel University Institutional Review Board (IRB) template. The co-investigators verbally summarized the content of the informed consent document. The twenty-seven subjects were then given the opportunity to read the document and ask any questions before signing the consent form. The participants gave the to allow any collected data to be used by the subject or to have all of their data removed from the study. Subjects were also informed of the confidentiality of their participation and data records, as well as the risks and benefits of participating in the study. To be included in the study, all subjects had to be able to fit within the specific parameters on the DXA body scanner as well as meet American College of Sports Medicine (ACSM) cut-off criteria for average body fat percentage ranges for both the male and female population [3]. One participant was excluded from the study due to inability to be positioned properly on the DXA leaving a sample size of twenty six.

2.1. Fasting plasma glucose test

Subjects were introduced to the purpose and procedures for the blood glucose test. Participants were then asked not to eat or drink anything (except water) for at least 9 h before coming to the Bethel University Biokinetics Laboratory. Subjects had their blood sugar tested via Point- of-Care finger-prick testing to determine their fasting glucose values in mg/dL. First, the area on one sterilized and a lancet was used to prick the finger to produce a small amount of blood. The blood was placed on a blood glucose strip connected to a plasma grade glucometer to be read. This test measured how the body handles glucose control after a 9+ hour fast. The contaminated glucose strip was then disposed of in a biohazard container. The values revealed if the participant had normal glucose control ($<$100 mg/dL), pre-diabetic levels (100–124 mg/dL) or diabetic levels ($>$124 mg/dL).

2.2. Waist to height ratio (WHtR)

WHtR was determined for all participants. The waist and height of each volunteer was measured in inches; a ratio was formulated by dividing the waist by the height to determine the trunk's adipose storage. A ratio greater than 0.5 is highly correlated with a pattern of excess visceral fat.

2.3. Generalized anxiety disorder 7 (GAD-7)

The 7-item Generalized Anxiety Disorder Scale (GAD-7) is a practical self-report anxiety questionnaire that's frequently used in primary care. Evidence supports reliability and validity of the GAD-7 as a measure of anxiety in the general population. The normative data provided in this study was used to compare a subject's GAD-7 score with those determined from a general population reference group. Subjects were asked to complete the GAD-7. The Generalized Anxiety Disorder 7-Item (GAD-7) is a self- administered patient questionnaire used screening tool and severity measure for generalized anxiety disorder. The GAD-7 contained seven items used to measure the severity of symptoms using reported response categories of "not at all," "several days," "more than half the days," and "nearly every day." Assessment of the disorder was indicated by the sum of the scores from all seven items, with a total score ranging from 0 to 21. The first two questions of the GAD-7 can also be used separately to screen for anxiety disorder, a method known as the GAD-2, using the same four response categories utilized by the GAD-7.

2.4. Dual-energy absorptiometry (DXA)

Each subject was fully briefed on the purpose, expectations, radiation exposure risks and proper clothing attire required needed for the body fat assessment. Proper clothing included a gym shirt and shorts; all metal jewelry or body art had to be removed prior to the body fat assessment. The purpose of the assessment was to measure each subject's total body fat composition. Body fat composition was analyzed using Bethel University's Dual-energy Absorptiometry (DXA) technology. Bethel University's principal investigator (PI), had been certified by the American Registry of Radiologic Technologists (ARRT), and was the only person operating the DXA machine. All DXA procedures were ARRT approved. The DXA is a safe yet accurate 3-compartment measurement technique that utilizes highly precise X-ray beams to measure bone density and body fat distribution. The test lasted between 6 to 10 min on fast scan mode and exposed participants to minimal radiation, resulting in a biologically effective dose of 0.037 mrem. Utilizing the fast scan mode decreased the amount of radiation exposure for the participants, as radiation exposure is proportional to the total amount of scan time. Additionally, Bethel's DXA equipment was a pencil-beam scanner that required less radiation exposure to function. Radiation protection protocol was followed to abide by the general principle of reducing radiation exposure to as low as reasonably achievable. To avoid unnecessary radiation exposure to the public, traditional X-ray warning signs were posted on the entrance to the exam room and entry into the room was restricted. Each subject was asked about any previous exposure to bone study techniques, where and when it was done and the specific machine used before the scanning procedure begins. Subjects who had any bone study techniques within the last year were not eligible to participate, as exposure to more radiation was considered unnecessary. The PI further protected each subject by correctly positioning the subject and choosing the proper scan mode settings. Any subject that was not able to be positioned correctly was not able to participate in this study. Signs that prompted female subjects to disclose a pregnancy or the possibility of a pregnancy were posted in the exam room, stating "Pregnant? If you are pregnant or think you may be, tell the X-ray technologist before having an X- ray taken" in both English and Spanish. Researchers did not assume each subject had read the posted sign, and directly inquired about the potential risk prior to the subject's scan. The PI was the only technologist in the exam room with the subject during the scan and not only chose the shortest appropriate scan speed to reduce radiation exposure but stood at least 3 feet away from the device during machine operation. Only when the scanning procedure was completely finished did any DXA technicians move within 3 feet of the machine.

In terms of body composition, the DXA scan was able to measure total body fat mass, distinguishing between fat and lean mass, android vs. gynoid fat storage patterns, visceral adipose tissue (VAT) as well as visceral adipose mass and volume, and evaluated the distribution of fat tissue in all subjects. Before the beginning of subject measurement, the PI calibrated the machine using phantom scans and would re-calibrate once a week during the data collection period. Each subject, after arriving for their appointment, would again be verbally read the risks of the DXA equipment and would also be allowed to view a written form of the risks. With the proper attire and all metal removed from the subject's body, each participant was also asked to remove their shoes in preparation to again take height and weight, using a meter stick and electronic scale, respectively. The co-investigators led the subject from the preparation room into the exam room with the DXA equipment where the participant was instructed to lie flat on the scanner and given thorough instructions of the subject's role