**CT Variables – Descriptions, Methods & References**

**During Exam 2 of JHS, approximately 2800 participants underwent CT of the chest and abdomen for measures including coronary artery and aorta artery calcification, liver fat, abdominal fat and a subset of participants also had pericardial fat measured.**

***Note: Recommended variables for each CT data type are hilited in green***

**Data Set: csta**

**Coronary Artery Calcification (CAC) Variables –** CAC has been measured as a non-invasive, sub-clinical imaging marker in multiple studies including Framingham, CARDIA, JHS and MESA.(Carr et al. 2005; Detrano et al. 2008; Liu et al. 2012; Reis, Launer, et al. 2013; Reis, Loria, et al. 2013; VanWagner, Ning, Lewis, Shay, Wilkins, Carr, Terry, Lloyd-Jones, Jacobs, et al. 2014) CAC is strongly associated with incident CVD. Total CAC derived using the Agatston scoring method (JHS variable CSTA24) is the most commonly used measure. Total Agatston CAC score is usually categorized as absent or present based on scores of 0 or >0, respectively. However, total Agatston CAC score may be categorized (ex. 0, 1-99, 100-299 or ≥300) or analyzed as a continuous variable (usually transformed due to its skewed distribution). In JHS, CAC methods were based on those used in other large studies to allow direct comparison. (Carr et al. 2005) The measurement of CAC in JHS was performed using FDA-approved TeraRecon software as described in Dr. Jeff Carr’s CT Reading Center. (Liu et al. 2012; Reis, Launer, et al. 2013; Reis, Loria, et al. 2013; VanWagner, Ning, Lewis, Shay, Wilkins, Carr, Terry, Lloyd-Jones, Jacobs, et al. 2014) Although Agatston scores are most often reported, other studies have reported CAC mass (JHS variable CSTA39) or volume (JHS variable CSTA29) scores which are also available in JHS. (Raggi et al. 2005; Terry et al. 2007) Further, the lesion counts (JHS variables CSTA15-CSTA19) might be used in an analysis of calcification distribution. All JHS CAC variables are available by coronary segment (ex. Left main segment lesion count is CSTA15) and as overall or total scores taking into account all coronary segments (ex. CSTA19 is total lesion count for all coronary segments).

**CSTA15** No. of Lesions Left Main *Count of lesions in segment based on visible calcifications*

**CSTA16** No. of Lesions Left Anterior Descending *Count of lesions in segment based on visible calcifications*

**CSTA17** No. of Lesions Left Circumflex *Count of lesions in segment based on visible calcifications*

**CSTA18** No. of Lesions Right Coronary *Count of lesions in segment based on visible calcifications*

**CSTA19** No. of Lesions All Coronary *Count of lesions in segment based on visible calcifications*

**CSTA20** Agatston Score Left Main *Agatston calcium score in segment (most often used scoring system)*

**CSTA21** Agatston Score Left Anterior Descending *Agatston calcium score in segment (most often used scoring system)*

**CSTA22** Agatston Score Left Circumflex *Agatston calcium score in segment (most often used scoring system)*

**CSTA23** Agatston Score Right Coronary *Agatston calcium score in segment (most often used scoring system)*

**CSTA24** Agatston Score All Coronary *Agatston calcium score in segment (most often used scoring system)*

**CSTA25** Volume of Lesions Left Main *Volumetric score for lesion size in segment*

**CSTA26** Volume of Lesions Left Anterior Descending *Volumetric score for lesion size in segment*

**CSTA27** Volume of Lesions Left Circumflex *Volumetric score for lesion size in segment*

**CSTA28** Volume of Lesions Right Coronary *Volumetric score for lesion size in segment*

**CSTA29** Volume of Lesions All Coronary *Volumetric score for lesion size in segment*

**CSTA35** Calcium Mass of Lesions Left Main *Mass score for segment based on phantom*

**CSTA36** Calcium Mass of Lesions Left Anterior Descending *Mass score for segment based on phantom*

**CSTA37** Calcium Mass of Lesions Left Circumflex *Mass score for segment based on phantom*

**CSTA38** Calcium Mass of Lesions Right Coronary *Mass score for segment based on phantom*

**CSTA39** Calcium Mass of Lesions All Coronary *Mass score for segment based on phantom*

**Chest Scan Quality Variables –** Chest CT quality variables are analyst ratings of CT scan with higher numbers representing better scans. Scans that were unanalyzable were excluded, but for questions about individual scans (in example, if data outliers are found), scan quality variables may be checked to verify that quality was adequate.

**CSTA40** Quality Variable Scan Coverage *Analyst subjective rating of scan coverage of heart (1=poor to 3=best)*

**CSTA46** Quality Variable Overall Quality *Analyst subjective rating of heart scan (0=unusable to 5=excellent)*

**Ascending Thoracic Aorta Calcification Variable –** This variable is a yes/no variable which the analyst coded based on visibility of calcified plaque anywhere within the ascending thoracic aorta.

**CSTA50** Ascending Aorta Calcified Plaque Present *Analyst sees or does not see calcification in ascending aorta*

**Abdominal Aorta/Iliac Calcification Variables –** Abdominal Aorta and Iliac calcification(AAC) has been less often used as an index of subclinical atherosclerosis than CAC. AAC is more likely to be present in an individual than CAC though and appears to be the site of earliest subclinical atherosclerosis development in most individuals. In JHS, 48% of subjects have CAC compared to 66% of subjects with prevalent AAC(Liu et al. 2012)**.** AAC and CAC share many of the same risk factors, but some appear to be more strongly associated with one or the other (Allison, Criqui, and Wright 2004; Liu et al. 2012). As with CAC, the most often reported variable for AAC is total Agatston AAC score (AAC= or >0) although segment-specific values are present in the JHS database as well.

**CSTA62** No. of Lesions Infrarenal Abdominal Aorta *Count of lesions in segment based on visible calcifications*

**CSTA63** No. of Lesions Left Common Iliac *Count of lesions in segment based on visible calcifications*

**CSTA64** No. of Lesions Right Common Iliac *Count of lesions in segment based on visible calcifications*

**CSTA65** No. of Lesions Aorta-Iliac *Count of lesions in segment based on visible calcifications*

**CSTA66** Agatston Score Infrarenal Abdominal Aorta *Agatston calcium score in segment (most often used scoring system)*

**CSTA67** Agatston Score Left Common Iliac *Agatston calcium score in segment (most often used scoring system)*

**CSTA68** Agatston Score Right Common Iliac *Agatston calcium score in segment (most often used scoring system)*

**CSTA69** Agatston Score Aorta-Iliac *Agatston calcium score in segment (most often used scoring system)*

**CSTA70** Volume of Lesions Infrarenal Abdominal Aorta *Volumetric score for lesion size in segment*

**CSTA71** Volume of Lesions Left Common Iliac *Volumetric score for lesion size in segment*

**CSTA72** Volume of Lesions Right Common Iliac *Volumetric score for lesion size in segment*

**CSTA73** Volume of Lesions Aorta-Iliac *Volumetric score for lesion size in segment*

**CSTA78** Calcium Mass Infrarenal Abdominal Aorta *Mass score for segment based on phantom*

**CSTA79** Calcium Mass Left Common Iliac *Mass score for segment based on phantom*

**CSTA80** Calcium Mass Right Common Iliac *Mass score for segment based on phantom*

**CSTA81** Calcium Mass Aorta-Iliac *Mass score for segment based on phantom*

**Abdominal Scan Quality Variables –** Scan quality and surgical intervention variables (the likely most useful variables below, but others included in the JHS database) are rated by the CT analysts during their scan evaluation and scoring. The quality variables are subjective, but may help explain an outlier variable if no other reason exists. All data reported from the CT reading center are considered usable though.

**CSTA82** Quality Variable Scan Coverage *Analyst subjective rating of scan coverage of abdomen (1=poor to 3=best)*

**CSTA88** Quality Variable Overall Quality *Analyst subjective rating of abdominal scan (0=unusable to 5=excellent)*

**Surgical Interventions Variables**

**CSTA92** Surgical Inventions Present *Analyst noted any sign of surgical intervention on scan*

**CSTA93** Coronary Artery Bypass Graft Present *Analyst saw evidence of previous CABG on scan*

**CSTA95** Coronary Stent Present *Analyst saw evidence of stent on scan* *(underestimate due to possible obscuring by heavy calcification)*

**Abdominal Adipose Tissue Variables --** Abdominal adipose tissue was measured in blocks of CT slices centered at L4-L5 disk space. The blocks were either 60 mm total (24 slices centered at L4-L5 disk space using 2.5 mm thick slices) or 10 mm total (4 slices centered at L4-L5 space using 2.5 mm thick slices). Within these blocks of CT slices, total adipose tissue volume (CSTA101, CSTA108) and visceral adipose tissue (VAT) volume (CSTA103, CSTA110), and visceral plus intramuscular adipose tissue volume (CSTA102, CSTA109) were measured and are included in the JHS dataset. Subcutaneous abdominal fat (SAT) may be derived from existing JHS variables using the formula: SAT=Total adipose tissue fat - VAT+muscle adipose tissue (ex. SAT = CSTA101 – CSTA102). Likewise, muscle fat volume may be derived by subtracting VAT from VAT plus muscle fat (ex. Muscle fat = CSTA102 - CSTA103). VAT is higher in men than women and more strongly associated with CVD risk factors and outcomes, including CAC, than SAT in most studies (DiTomasso et al. 2010; Fox et al. 2007). In JHS as in other studies, VAT is associated with increases in risk factors including glucose, triglycerides, blood pressure, and reduction in HDL cholesterol (Liu, Fox, Hickson, May, et al. 2010).

**CSTA101** Total Fat Volume for 60 mm of Abdomen *Total fat volume in cm3 within a 60 mm block of abdominal images centered at L4-L5 disk space*

**CSTA102** Visceral and Intramuscle Fat Volume for 60 mm of Abdomen *Visceral plus muscle fat volume in cm3 within a 60 mm block of abdominal images centered at L4-L5 disk space*

**CSTA103** Visceral Fat Volume for 60 mm of Abdomen Visceral *fat volume in cm3 within a 60 mm block of abdominal images centered at L4-L5 disk space*

**CSTA104** Total Volume for 60 mm of Abdomen *Total volume (all tissues, organs, and space) in cm3 within a 60 mm block of abdominal images centered at L4-L5 disk space*

**CSTA108** Total Fat Volume for 10 mm of Abdomen *Total fat volume in cm3 within a 10 mm block of abdominal images centered at L4-L5 disk space*

**CSTA109** Visceral and Intramuscle Fat Volume for 10 mm of Abdomen *Visceral plus muscle fat volume in cm3 within a 10 mm block of abdominal images centered at L4-L5 disk space*

**CSTA110** Visceral Fat Volume for 10 mm of Abdomen Visceral *fat volume in cm3 within a 10 mm block of abdominal images centered at L4-L5 disk space*

**CSTA111** Total Volume for 10 mm of Abdomen *Total volume (all tissues, organs, and space) in cm3 within a 10 mm block of abdominal images centered at L4-L5 disk space*

**Liver Adipose Tissue Variable –** Liver adipose content was also measured from the JHS Exam 2 CT.Unlike abdominal adipose measures, the liver measures are reported in Houndsfield Units (HU) rather than volume. The liver attenuation, a measure of fat content, decreases with fat content of the liver. Therefore, lower liver attenuation in HU is associated with fattier liver. HU may range to below zero in some cases of fatty liver. Although HU is continuous, many researchers believe that based on biopsies, an HU of 40 or less indicates non-alcoholic fatty liver disease (NAFLD) in the absence of alcohol abuse or other possible causes including certain medicines(e.g. estrogen, corticosteroids, and amiodarone). High liver attenuation (>~80) may be associated with use of certain medicines as well. Three individual regions of interest (ROI) were measured in the right side of the liver for JHS. Analysts are careful to avoid obvious vascular tissue or cysts. The 3 ROIs are usually very consistent and may be averaged to get mean HU. Fatty liver has been associated with CVD risk factors, other fat depots and measures, and calcification in JHS (Liu et al. 2011, 2012). In CARDIA, fatty liver was associated with CAC, but the association was not independent from BMI or VAT (VanWagner, Ning, Lewis, Shay, Wilkins, Carr, Terry, Lloyd-Jones, Jacobs Jr., et al. 2014).

**lfat\_roi\_1** liver attenuation measure number 1 (HU)

**lfat\_roi\_2** liver attenuation measure number 2 (HU)

**lfat\_roi\_3** liver attenuation measure number 3 (HU)

**Pericardial Adipose Tissue (PAT) –** Pericardial adipose tissue (PAT) was measured on 1414 JHS Exam 2 CT scans as part of an ancillary study (Jiankang Liu, PI).PAT volume was measured as described in MESA(Ding et al. 2008, 2009; Liu, Fox, Hickson, Sarpong, et al. 2010). PAT includes both epicardial (within the pericardium) and paracardial adipose (superficial to the pericardium) depots. PAT is highly correlated with VAT (Ding et al. 2008; Liu, Fox, Hickson, Sarpong, et al. 2010). PAT has been associated with CVD risk factors and CAC in both JHS and MESA (Ding et al. 2008; Liu, Fox, Hickson, Sarpong, et al. 2010) and has been associated with incident CVD after adjustment for BMI in MESA (Ding et al. 2009).

**Pericardial fat** pericardial adipose tissue volume (cm3)

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