RSNA Radiological Society of North America
RADIOLOGICAL SOCIETY OF NORTH AMERICA
820 JORIE BLVD, OAK BROOK, IL 60523
TEL 1-630-571-2670 FAX 1-630-571-7837
RSNA.ORG
NEWS

QUANTIFYING CHRONIC STRESS AND CARDIOVASCULAR RISK VIA ADRENAL VOLUME ON CHEST CT: AN OPPORTUNISTIC DEEP LEARNING APPROACH IN THE MESA

PURPOSE

Chronic stress contributes to cardiometabolic risk but remains difficult to measure objectively. As adrenal hypertrophy may reflect prolonged stress, we hypothesize that adrenal volume—quantified opportunistically from routine chest CT using deep learning—serves as a noninvasive imaging biomarker of chronic stress and predicts long-term cardiovascular outcomes.

METHODS AND MATERIALS

We included participants from Exam-5 of the Multi-Ethnic Study of Atherosclerosis whose adrenal glands were fully visualized in the inferior slices of non-contrast chest CT; those with adrenal masses were excluded. Multiplanar manual segmentations were used to train a Swin UNETR model in MONAI, initialized with self-supervised pre-trained weights from 5,050 CTs and trained on 55 scans using DiceCELoss with patch-based augmentation. Preprocessing included voxel resampling and intensity clipping; augmentations included random flipping and intensity scaling. Total adrenal volume was calculated from 3D mesh segmentations using PyRadiomics. Adrenal Volume Index (AVI) was defined as volume (cm^3) divided by height^2 (m^2). Salivary cortisol was collected 8×/day over 2 days; cortisol AUC represented total exposure. Allostatic load was computed from BMI, creatinine, hemoglobin, albumin, glucose, WBC, heart rate, and blood pressure. Linear regression assessed associations between AVI and cortisol, allostatic load, and psychosocial stress measures, including validated depression and perceived stress questionnaires. Cox models estimated hazard ratios for cardiovascular events and mortality over 8.2 years.

RESULTS

We analyzed 2,842 participants (mean age 69.3 ± 9.2 years; 51% female). The DL model achieved a Dice score of 0.81 ± 0.09. Median adrenal volume was 9.6 ± 4.6 cm^3. Higher AVI was associated with greater cortisol AUC ($\beta = 0.06$; 95% CI: 0.02-0.10; $p < 0.001$), peak cortisol ($\beta = 0.07$; 95% CI: 0.01-0.13; $p = 0.02$), and allostatic load ($\beta = 0.07$; 95% CI: 0.04-0.10; $p < 0.001$). Participants with high perceived stress had 0.23 cm^3/m^2 higher AVI compared to those with low stress (95% CI: 0.03-0.43; $p = 0.01$). AVI was also associated with higher LV end-diastolic mass index ($\beta = 2.65$ g/m^2; 95% CI: 2.59-2.70; $p < 0.001$). Each 1 cm^3/m^2 increase in AVI was linked to greater risk of heart failure (HR = 1.044; 95% CI: 1.001-1.090) and mortality (HR = 1.045; 95% CI: 1.008-1.080).

CONCLUSIONS

Deep learning-derived adrenal volume from chest CT correlates with chronic stress biomarkers, increased left ventricular mass, and predicts risk of heart failure and all-cause mortality.

CLINICAL RELEVANCE/APPLICATIONS

Routine chest CT scans reveal adrenal volume, a new noninvasive biomarker of chronic stress, potentially identifying patients at high risk for heart failure and early cardiovascular events.