# C. SPECIFIC AIMS

There is a key knowledge gap in the understanding of the mechanisms underlying depression and coronary artery disease (CAD).1 This is a major public health issue, considering that depression is the leading cause of disability in the world, and CAD is the leading cause of death.They are also comorbid and likely share common mechanisms: depression affects up to 20% of patients with coronary artery disease (CAD) and is associated with a 3-fold increase in cardiovascular mortality.2–4 Our knowledge gaps are underscored by negative studies that show that current treatments for depression in CAD patients have modest effects in reducing depressive symptoms and no impact on CAD outcomes.5,6 A common mechanistic pathway for depression and CAD is dysfunction of autonomic nervous system (ANS). Although current treatment strategies do not specifically target the ANS, research into such therapies may be promising, given the strong biological relationships that exist.7,8 Vagal nerve stimulation, for example, may be effective in treatment-resistant depression,9 angina pectoris,10 and cardiac arrhythmias.11 We seek to gain a better understanding of relationship of ANS biomarkers that can help understand the heart-brain relationship and uncover effective therapies for both.

We have recently investigated a novel electrocardiographic (ECG) biomarker of ANS dysfunction, *Dyx*, that was predictive of abnormal myocardial perfusion and coronary flow reserve,12 as well as depressive symptoms. Encouraged by these findings, we seek to further explore its potential as a means of investigating dysfunction in both central neurological processes (depression) as well as peripheral cardiovascular reflexes as they relate to obstructive CAD. Both mechanisms can influence the adaptability/flexibility of the ANS, which can be measured by heart rate variability (HRV). *Dyx,* we have found, is a particularly promising HRV metric, and measured in a low cost/burden manner with ambulatory ECG.13,14 *Dyx* is derived from an algorithm of the heart rate time series that measures the unpredictability and variability of the heart rhythm.18 Other studies have also found low *Dyx* to predict ventricular dysrhythmia and cardiovascular mortality;19,20 in addition, individuals with chest pain who had low *Dyx* values were found to have an odds ratio of 8 for having positive stress test results.21,22 Overall, *Dyx* may serve as an important clinical biomarker, but more studies are needed.

The autonomic pathways that underlie depression and CAD may be most concerning for young women. My mentors, Drs. Shah and Vaccarino, have found that depressive symptoms and CAD are most strongly associated in women less than 60 years of age; in addition, young women are twice as likely to have depression and myocardial ischemia with mental stress.23 HRV is strongly affected by both age and sex,23,24 and in preliminary work we found that abnormal HRV was most strongly associated with depressive symptoms in younger women. By studying how Dyx and its relationships with depression and CAD may differ by age and sex, we can better understand mechanisms that may be potentially specific to this high risk group.

We seek to study these ANS pathways a prospective cohort study of high risk symptomatic patients referred for angiography in the Emory Cardiovascular Biobank (Dr. Arshed Quyyumi , PI (advisor)).23,25 We will examine both depressive symptoms (via Patient Health Questionnaire-9 or PHQ-9)27and HRV using a newly developed ECG patch in 100 patients prior to catheterization,26 and aim to examine the shared ANS mechanism between depression and CAD. Furthermore, we will oversample young women (≤60 years of age) to better power evaluation of sex differences. Our aims are:

**Aim 1. Quantify the relationship between depressive symptoms and ANS dysfunction.** *We hypothesize elevated PHQ-9 scores will associate with low Dyx.*

**Aim 2. Examine the relationship of obstructive CAD with ANS dysfunction and its potential dose-response relationship.** *We hypothesize that low Dyx will associate with obstructive CAD (stenosis > 70%), and that lower Dyx will associate with a greater number of obstructed vessels in a dose-response manner.*29

**Aim 3. Study the interaction of age and sex in the relationships between ANS dysfunction and both depression and CAD**. *We hypothesize that the relationships of Dyx with both depression and CAD will be stronger in young women (≤60 years) than men or older women (>60 years).*

This project that also includes examination of long-term This multidisciplinary, collaborative team has shown evidence of effective collaborations as well.1,30–32 Collectively, our work can help lay the groundwork for future clinical trials on ANS therapies such as vagal nerve stimulation, and also help bridge the gap in gender disparities in both depression and CAD.33 **REFERENCES**

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