Title: “The Effect of Shift Work on Arterial Stiffness in Law Enforcement Officers”

Jason M. Keeler, M.S.
University of Kentucky
Department of Kinesiology and Health Promotion
Introduction
Cardiovascular disease is the leading cause of death in the United States. CVD among Law Enforcement Officers (LEOs) has been suggested to have a similar or slightly increase morbidity as the general population (13). However, the prevalence of CVD is doubled for LEOs following retirement compared to the general population (14, 21). The rapid progression of CVD in LEOs necessitates the investigation of CVD risk factors and assessments in this population. Earlier detection and intervention can provide LEOs a greater chance of avoiding CVD at earlier ages. Investigation and discovery of population prevalent CVD risk factors would provide practitioners with vital information to generate appropriate health-based screenings and interventions. Investigators have studied a multitude of traditional risk factors in LEOs, and some have even looked at interventions to help in decreasing these risk factors (13, 14, 16, 21). The primary findings of these studies showed LEOs are at great risk of hypertension, obesity, and they lack the necessary physical activity to maintain good cardiovascular health (13, 14, 17, 21). LEOs also exhibit large amounts of physical and psychological stress, which also increases CVD risk (3, 9).

Varvarigou et al. noted that sudden cardiac death occurred in about 10% of the fatalities of LEO deaths on duty, and was associated with more physically demanding tasks such as restraints/altercations, pursuits of suspects, and physical training (18). In another civil tactical population, firefighters, it has been found that arterial stiffening increases during a 3-hour bout of firefighting activity, which may suggest that stiffening is occurring and causing the sudden cardiac deaths (4). Stressors, both physical and psychological, could be at play in these sudden cardiac deaths. Psychological stress has been connected to vascular dysfunction, CVD, impaired sleep, and depression (9). An investigation by Ramey et al. depicts the variety of psychological stressors placed on LEOs each day (15). A goal of the proposed project is to investigate how arterial stiffness is connected with perceived stress based on a questionnaire.

While traditional risks factors give some insight to the cardiovascular health of LEOs, the measure of arterial stiffness may provide practitioners with greater insight. Arterial stiffness as measured by the “gold-standard” of carotid-femoral pulse wave velocity (cfPWV) has been linked to predicting cardiovascular events and all cause mortalities in many epidemiological studies (1, 7, 10, 11, 19). The investigation of central arterial stiffness can detect earlier changes in the vasculature compared to brachial blood pressure measurements (10). Central stiffness measurements have been found to be a stronger prediction of first cardiovascular events compared to the typical brachial measurements (19). Normal aging causes progressive escalation of arterial stiffness and hypertension (8), however accelerated increases of both factors occur within individuals who are overweight/obese or lack daily recommended physical activity levels (6). Shift work has also been proposed as an accelerant of arterial stiffening in a bus driver population (2). Shift work is also known for increasing traditional risk factors within law enforcement (20). The measure of arterial stiffness has not been performed in the LEO population to the researchers’ knowledge. The measurement will provide a new cross-sectional perspective on how the vascular system maybe adapting throughout a career in law enforcement.

SPECIFIC AIMS
The goal of this project will be to determine the effects of shift, stress, and daily physical activity level have on arterial stiffness in a population of professional Law Enforcement Officers. To achieve this goal, the following aims are proposed:

AIM 1: Determine the effects of shift on arterial stiffness in law enforcement officers.
AIM 2: Determine the effects of stress on arterial stiffness in law enforcement officers.
AIM 3: Determine the effect daily physical activity on arterial stiffness in law enforcement officers.

METHODS
Participants
A total of 60 professional male law enforcement officers will be recruited to participate in this study, with half from 1<sup>st</sup> and half from 3<sup>rd</sup> shifts. Subjects will be between the ages of 20-50 years. Subjects must complete informed consent forms, a Physical Activity Readiness Questionnaire (PAR-Q), and a medical history questionnaire. **Exclusion criteria:** Women officers will be excluded because measurements of arterial stiffness are not comparable between sexes. Also the law enforcement population is predominantly male (~80%). Subjects with known cardiovascular disease or are taking nitroglycerin medication, will be excluded because of changes in wave reflections and an underestimation of arterial stiffness due to medication.

**Study Design**
This study will utilize a cross-sectional descriptive comparison to evaluate the effects of law enforcement shift work on arterial stiffness. This study will also use a cross-sectional descriptive comparison to evaluate the effect of stress on arterial stiffness among law enforcement officers.

**Experimental Approach**
All participants will be asked to attend one testing session located at the Exercise Physiology Laboratory at the University of Kentucky. Participants will be asked to complete the informed consent form. Following completion of the informed consent, participants will be screened using a PAR-Q and Medical History Questionnaire. Subjects will be excluded if they meet any of the exclusion criteria. Subjects will then be asked to complete additional questionnaires to assess sleep/sleep disorders, stress (the Operational and Organizational Police Stress Questionnaire), and personal work history questionnaire.

Once the subject is cleared to participate, initial measurements will be obtained. A trained technician will obtain blood pressure manually, while the subject is in a seated position. Height will be measured (to the nearest 0.1cm) using a wall-mounted stadiometer. Weight will be collected (to the nearest 1kg) using an electronic scale. Circumference measurements will be taken (to the nearest 0.1cm) at the waist, abdomen, and hip according to American College of Sports Medicine guidelines (12). Each circumference will be repeated until 2 trials are within 1cm. The waist circumference measurement is located at the narrowest part of the torso below the rib cage. The abdomen circumference is taken at the level of the Navel. The hip circumference is taken at the greatest protuberance of the Gluteus Maximus.

Subject body composition will also be measured with the use of a multi-frequency bioelectric impedance analyzer (BIA; Bodystat Quadscan 4000; Bodystat Ltd., Isle of Man, British Isles). Subjects will be in a supine position on a non-conductive surface with the limbs slightly abducted from the body. Two surface electrodes placed on the subject’s right side. The first will be placed, on the posterior wrist, bisecting the radial and ulnar head. The second electrode will be placed on the anterior ankle bisecting the lateral and medial malleoli. A series of low-level electrical currents (5, 50, 100, and 200 Khz) will be released, and the voltage drop due to the impedance will be detected across the sensor. Appropriate population specific equations or the manufacturer’s proprietary prediction equation will be used in order to estimate the subjects’ body composition.

Carotid-Femoral Pulse Wave Velocity (cfPWV) is the “gold standard” measurement of arterial stiffness, and it will be assessed via transcutaneous tonometry of the carotid and femoral arteries with simultaneous ECG recording (SphygomCor). The subject will be supine with each measurement performed on the right side of the body. Subjects will have three electrodes placed on the chest to measure heart rhythm; chest hair may need to be shaved prior to electrode placement. Subject will be allowed to rest quietly for 10-15 minutes prior to measurement. The Carotid and Femoral measurement sites will be palpated to find the strongest pulse, and then marked with a washable marker. Measurement of the distance between the sites will be taken from Carotid Site, to the sternal notch, to the navel, and then to the Femoral Site. Also a pulse wave analysis measurement will be performed with transcutaneous tonometry at the radial artery, following manufacturer’s guidelines.
Daily physical activity will be evaluated over one week with the use of a Fitbit Zip activity tracker (Zip, Fitbit Inc., San Francisco, CA) and an accelerometer (GT3X, ActiGraph Inc., Pensacola, FL). Subjects will be asked to wear the Fitbit Zip activity tracker on their hip at the mid-axillary line, while awake. The accelerometer will be worn while awake and asleep to get measurements of sleep quality and physical activity. The accelerometer will be worn on the wrist. Daily steps, energy expenditure, and active minutes will be recorded and used to determine relative daily activity levels from the Fitbit Zip. Accelerometer will provide activity data through step counts and activity counts. The activity count data will be utilized to quantify volume, intensity, frequency, and duration of participants’ physical activity. Threshold of physical activity intensities have been defined by Freedson et al. (5). Accelerometer will be worn around the subjects’ wrist when going to sleep for 7 days/nights. The device will measure sleep onset, sleep latency, total sleep time, number and duration of awakenings, and sleep efficiency. All data will be downloaded to a personal computer, and will be evaluated using the manufacturer’s software. Additionally, subjects will be asked to keep a written physical activity log and sleep log to keep track of duration of these activities.
References