INTRODUCTION
Lumbar spinal musculature plays a critical role in equilibrium, stability, and control of the spine. Recently, the clinical importance of spinal musculature is being emphasized in conditions such as lower back pain, and spinal deformity [1]–[3]. To improve our general understanding of spinal musculature, spine models have been developed and refined [4], [5]. Typically however, these models are validated using supine magnetic resonance imaging (MRI) which may not be representative of spinal musculature in natural upright and weighted postures [5], [6]. Therefore, the objective of this study is to characterize asymptomatic lumbar spinal musculature in varying postures using upright open MRI. Parameters to be measured include anatomical cross sectional area (CSA), centroid, radius, and angle of the lumbar muscles (multifidus, erector spinae, and psoas major) between L3-S1 spinal levels. Of particular interest is how these parameters vary in upright and seated postures in comparison to typical supine imaging. In the future, these imaging results could help inform more accurate lumbar spine model development.

PROPOSED METHODS
10 healthy volunteers will be imaged using a 0.5T MROpen scanner (Paramed Medical Systems) in 7 postures, and half will be re-scanned for repeatability. They will be scanned using a T1-weighted imaging sequence, with a slab imaging method where 3 image slices will be obtained at each intervertebral level of L3/L4, L4/L5, and L5/S1. Each scan requires 1 min and 51 sec scanning time. The volunteer will be scanned in the 7 of; standing, standing holding an 8kg weight, standing bent forward at 45°, supine, seated bent 45° back, seated at 90°, and seated bent 45° forward.

Image analysis measurements of muscle CSA, centroid, radius, and angle will be taken on each muscle of interest; the multifidus, erector spinae, and psoas major muscles as shown in Figure 1 [7]. Due to image quality, it is often difficult to differentiate between the multifidus and erector spinae muscles, and consequently they will be considered together. Muscle CSA (mm²) will be calculated by manually tracing the outline of the muscle boundary, and its centroid will be defined as the geometric center. Angle (degrees) will be measured relative to the line running posteriorly from the vertebral body centroid to the spinous process. Radius (mm) will be measured as the distance between the centroid of the muscle to the centroid of the vertebral body.

Image analysis will be performed by 1 individual, with repeatability and validation performed by an expert analyzing images from 1 to 2 volunteers in all postures. Statistics will include analysis of variance to consider how measurements of specific spinal levels change across different postures, as well as Pearson’s coefficient for inter-observer agreement with the expert’s measurements.

PRELIMINARY RESULTS AND DISCUSSION
For the proposed methodology, one volunteer was scanned in all 7 postures. An example plot for muscle CSA for the right multifidus and erector spinae muscles is shown (Figure 2). Notably, the CSA at a specific spinal level is not constant across postures. For example, for the L3/L4 level, the CSA ranges between 1577mm² to 1929mm² depending on posture. Overall, it was observed that muscle CSA, radius, and angle are not equal across different postures. Though this is only preliminary data from one volunteer, these variations in measurements could indicate that the study of lumbar spinal musculature in different postures using upright open MRI merits further investigation.

CONCLUSIONS
In conclusion, this proposed study hopes to provide some insights into the lumbar spinal musculature in a variety of upright postures for comparison to traditional supine imaging. In the future, these imaging results could help inform more accurate lumbar spine model development for an improved understanding of the lumbar spine.

REFERENCES