

# Full Body Magnetic Resonance Imaging from Health Nucleus

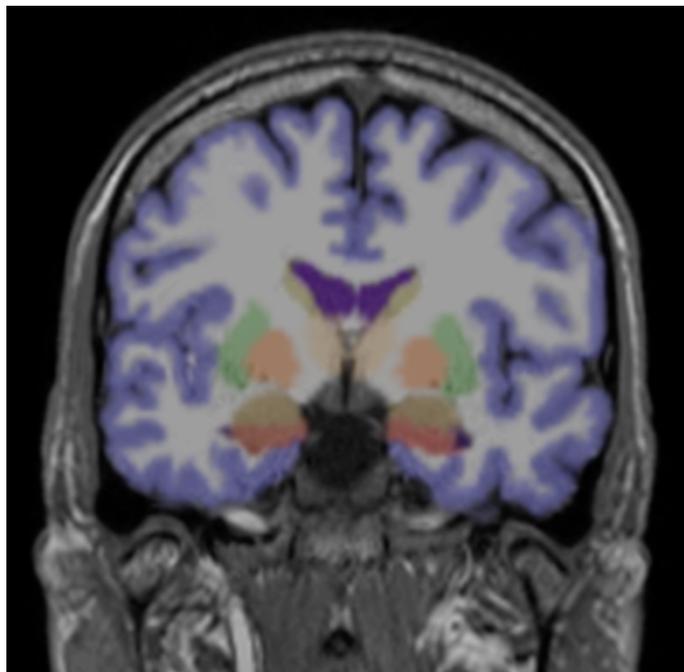
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Full Body Magnetic Resonance Imaging (MRI) at Health Nucleus includes comprehensive imaging of the head, neck, chest, abdomen, and pelvis. Below are detailed descriptions of each component and how it is used to provide the client with an overview of their current health status as illustrated by imaging.

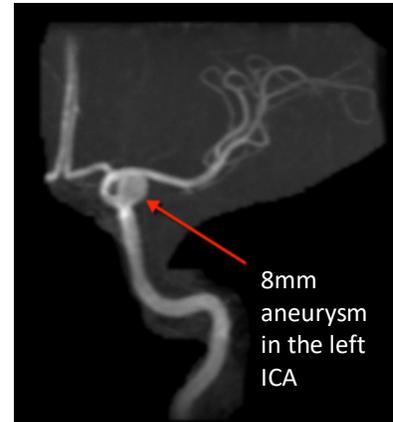
## Dedicated Brain MRI

The dedicated brain MRI from Health Nucleus is designed to show detailed images and focuses on the acquisition of imaging biomarker data. The resulting data is comprised of high-resolution 3D anatomic images, angiogram, and specialized sequences for early detection of brain abnormalities including white matter hyperintensity, gliosis, neurodegeneration, calcification, blood products, and tumors.

Using the 3D anatomic images, AI Neuro provides morphometric measures using machine learning brain segmentation. The segmentation is fully automated, providing volumetric quantification and colored visualization of brain structures along with average population comparative percentile data adjusted for age and sex. The advantage of brain segmentation is that it provides objective clinical data to the clinical team in the form of automatically derived volumetric values and color-coded brain structures to assess and monitor biomarkers of neurodegenerative brain disorders. The segmentation uses a 3D fully convolutional neural network developed with over 3600 training samples of individuals diagnosed with dementia and mild cognitive impairment alongside normal controls from National Alzheimer's Coordinating Center (NACC). The accuracy of the AI Neuro segmentations was validated using 20 sets of brain MR images from four different MRI scanners from two different MRI manufacturers located at three different sites in comparison with manual segmentations. Manual segmentations were performed by an expert from Neuromorphometrics, Inc. The current report details quantitative data for three anatomical regions (hippocampus, inferior lateral ventricles, lateral ventricles) and qualitative color visualization of 13 sub-regions.

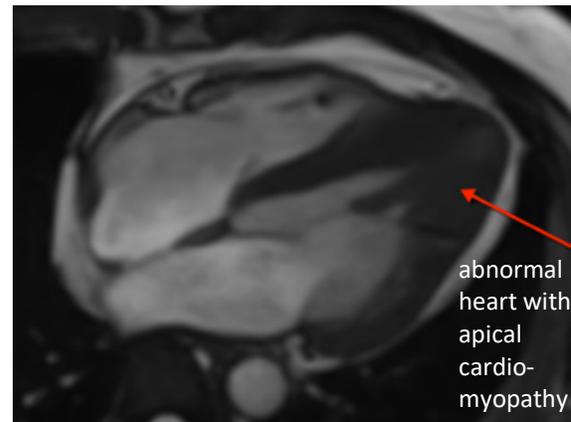


The non-contrast angiogram examines the brain's blood vessels and can find brain aneurysms as small as 3 millimeters in diameter. The resulting images are integrated with the client's genetic data and other clinical data to identify personalized and actionable individual health risks as a basis for early detection and prevention of neurologic disease.



### Dedicated Cardiac MRI

The dedicated cardiac MRI includes images of multiple views of the heart throughout its pumping cycle. This non-contrast technique examines the heart's function, tissue characterization and cardiac valves. Ejection fraction, which is how much of the blood in the left ventricle gets ejected on each beat, can be calculated using the acquired images. An ejection fraction of 60% means that 60% of the blood is ejected every time the left ventricle contracts. A cardiologist reviews and reports ejection fraction along with other quantitative cardiac biomarkers at Health Nucleus.



### Whole-Body Imaging

The whole-body MRI also focuses on the acquisition of imaging biomarkers, which are risk factors for future cancer and other diseases, while providing a comprehensive cancer screening (excluding skin, GI tract, and breast; see Figure 1). These scans are acquired starting at the top of the head and extending to the mid-thigh. The full body scans form the core of the images with the addition of dedicated imaging of the liver, prostate, and pelvis to derive liver fat, liver iron deposition, and more detailed assessment of reproductive organs. Also included is a dedicated scan of the pancreas to facilitate early detection of pancreatic cancer which is otherwise often asymptomatic and difficult to detect. These scans are merged and composed by HLI to produce a PET-like display of the images to aid in early detection of pathology all without the use of contrast agents and ionizing radiation. This imaging acquisition lasts up to 35 minutes, depending on the sex and height of client. In Health Nucleus's first 1,196 clients, the whole-body MRI revealed 343 clients had elevated liver fat, 104 clients had elevated liver iron, and 20 clients had early-stage neoplasia including prostate adenocarcinoma, renal cell carcinoma, lymphoma, transitional cell carcinoma, papillary thyroid cancer, pancreatic cancer, mediastinal thymoma and others<sup>1</sup>.

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<sup>1</sup> Hou YC, Yu H, Martin R, et al. Precision medicine integrating whole-genome sequencing, comprehensive metabolomics, and advanced imaging. PNAS. National Academy of Science; 2020;117(6):3053–3062.

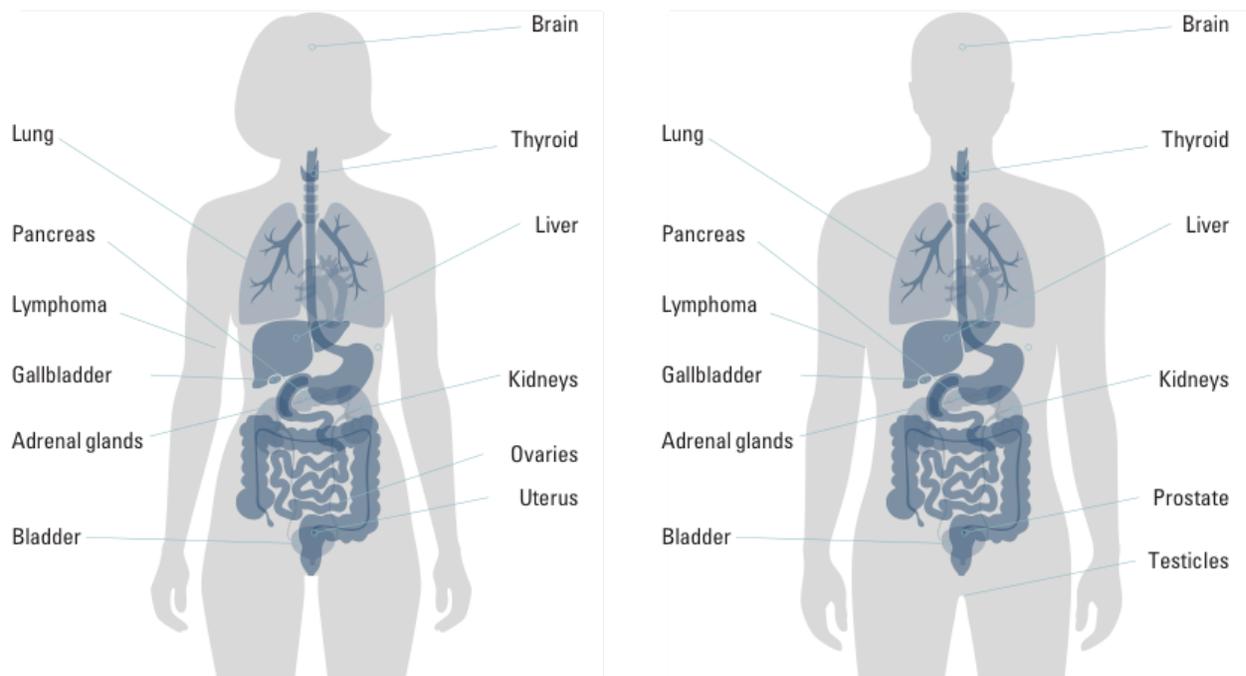


Figure 1 Illustration of the organs that are evaluated using whole-body MRI.

## Interpretation

The Health Nucleus radiology team has unique and unparalleled expertise in the interpretation of whole-body imaging, having read close to 5000 whole-body imaging exams. A second Board-certified radiologist over-reads every exam to minimize false positives and false negatives. Quantitative imaging biomarkers are reported, and images are evaluated for the presence of all abnormal anatomical findings.

## Body composition

Also included in the whole-body MRI is an additional set of images for measuring whole-body tissue composition. These scans were developed to achieve segmentation and quantification of the client's muscle and adipose tissue. The 3D anatomic MRI scans include the full body from the top of the head through the client's knees. These are integrated into the whole-body acquisition at Health Nucleus but could also be done as a stand-alone series and take less than ten minutes to perform. Body composition data is derived using an automated method (with manual quality control) for the classification and quantification of fat and muscle groups<sup>2</sup> and provides valuable information regarding early onset of metabolic disease and provides multiple biomarkers for determining the client's risk for cardiovascular disease, diabetes, and metabolic syndrome, including measurements of visceral fat, subcutaneous fat, and thigh muscle volume.

<sup>2</sup> Borga, M., Ahlgren, A., Romu, T., et al. Reproducibility and repeatability of MRI-based body composition analysis. *Magnetic Resonance in Medicine*. 2020;84(6):3146-3156.

## Cancer screening

Whole-body imaging exams performed at Health Nucleus provide a comprehensive cancer screening of many core organs (excluding skin, GI tract, and breast for now) including dedicated imaging of the brain, liver, pancreas, prostate (for men), and pelvis (for women). The image acquisition at Health Nucleus is similar to those used for detection of metastatic prostate cancer<sup>3</sup> and multiple myeloma<sup>4</sup> in at-risk populations, and has been optimized for use in asymptomatic patients from the general population and includes a fully automated visualization tool for cancer detection. Color-coded “heat” maps overlaid on whole-body anatomic MR images enhance the ability of reading radiologists to detect pathological features (such as cancer) quickly and accurately without the use of injected contrast agents and ionizing radiation.

Images are assessed using multiple sequences; diffusion imaging is evaluated in conjunction with anatomical imaging, with the images linked and properly co-registered to aid in diagnosis. Great care is taken to avoid both false positive and false negative findings. A standard reporting protocol is used, with findings assigned to a specific anatomical region. Each finding is carefully documented with a text description and an assessment of the likelihood of malignancy.

The combined protocols provide a comprehensive assessment including neurodegenerative, vascular and cardiovascular assessment, metabolic analysis, and early cancer detection. Integrating the imaging data with the genetic and blood data reduces false positives and false negatives for the client’s risk assessment of progression towards age-related disease. Understanding the client’s personalized health risks gives the client the opportunity to make lifestyle choices to optimize health and prevent disease before it starts. Unlike full body CT scans and/or PET scans, radiation-free MRIs allow for yearly repeat analysis, without increased risk of DNA damage and subsequent cancer. Annual assessment provides clients with updated reports that track meaningful imaging biomarkers for monitoring and optimizing the clients’ health over time.

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<sup>3</sup> Padhani AR, Lecouvet FE, Tunariu N, et al. METastasis Reporting and Data System for Prostate Cancer: Practical Guidelines for Acquisition, Interpretation, and Reporting of Whole-body Magnetic Resonance Imaging-based Evaluations of Multiorgan Involvement in Advanced Prostate Cancer. *Eur Urol*. Elsevier; 2017;71(1):81–92.

<sup>4</sup> Messiou C, Hillengass J, Delorme S, et al. Guidelines for Acquisition, Interpretation, and Reporting of Whole-Body MRI in Myeloma: Myeloma Response Assessment and Diagnosis System (MYRADS). *Radiology*. Radiological Society of North America; 2019;291(1):5–13.