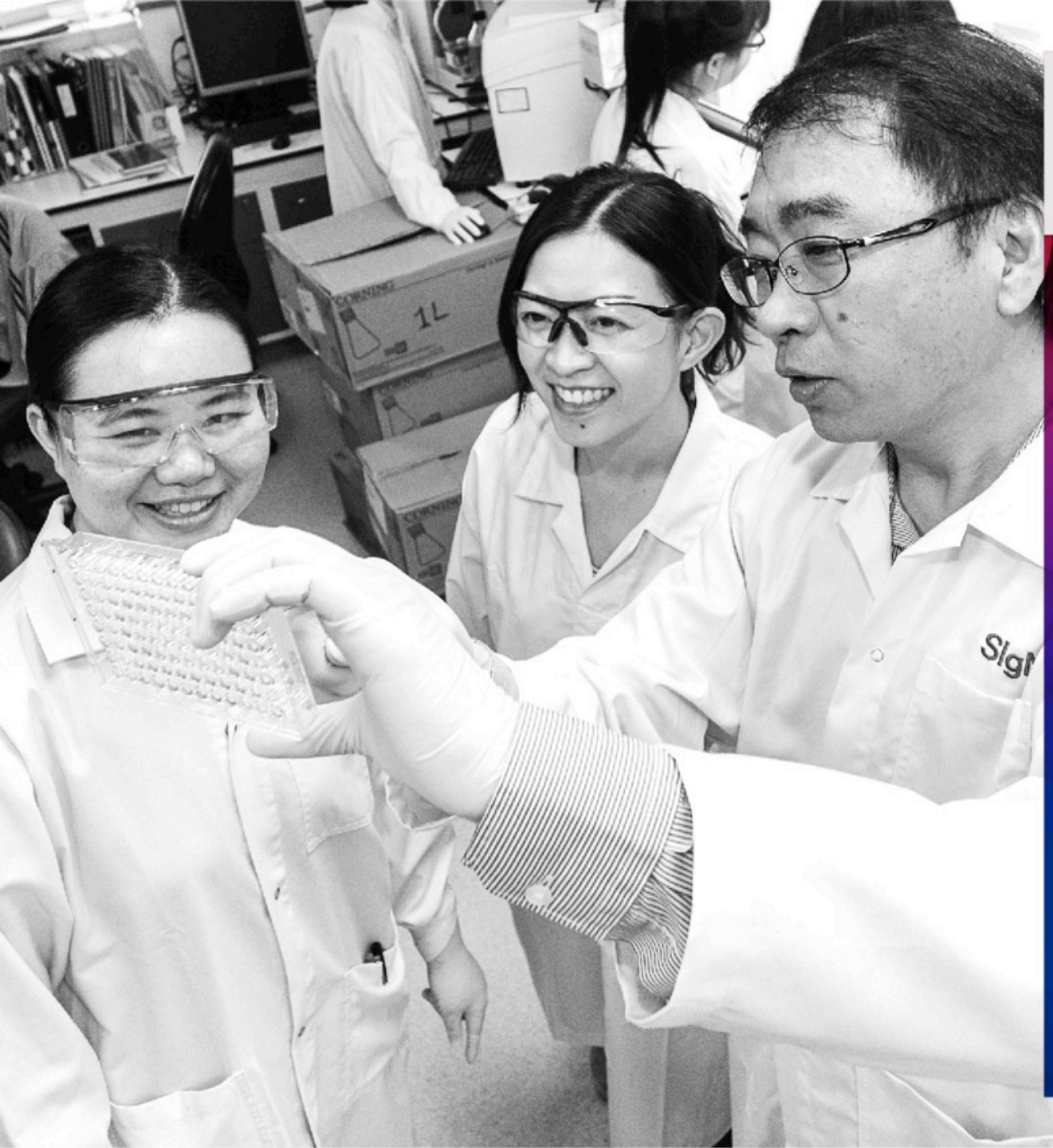


Agency for Science, Technology and Research
SINGAPORE

CLINICAL DATA ANALYTICS & RADIOMICS

Bhanu Prakash KN
Principal Investigator

Bioinformatics Institute, A*STAR

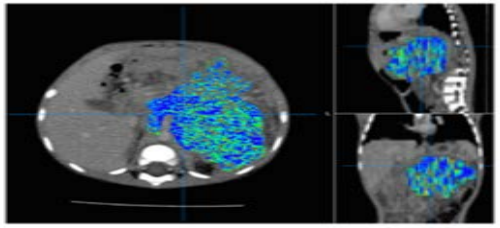
29th March 2022

Overview -

CREATING GROWTH, ENHANCING LIVES

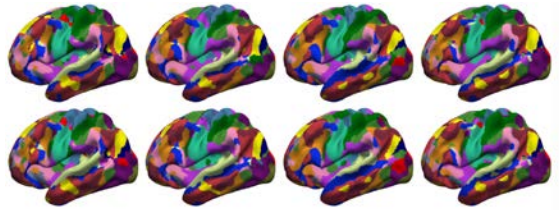
KK Women's and Children's Hospital SingHealth

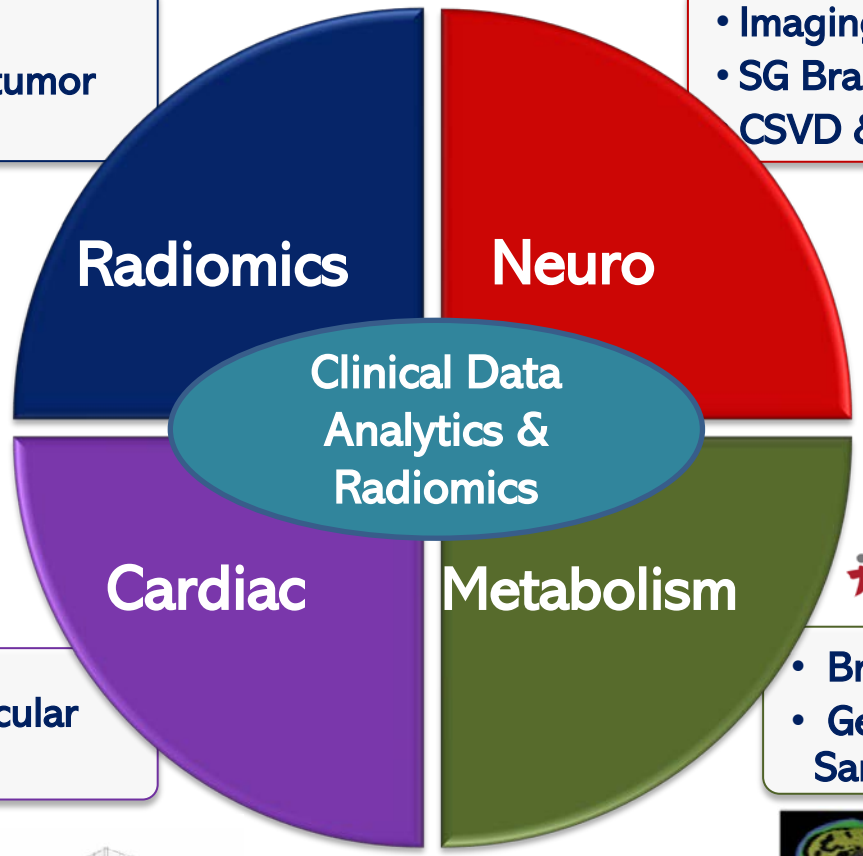
- Multi-modal imaging based Pediatric brain / non-brain tumor analysis



Institute of Mental Health National Healthcare Group · Sengkang General Hospital SingHealth · Universiti Sains Malaysia · Yishun Health National Healthcare Group

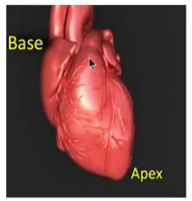
- Imaging biomarkers for Psychiatric disorders
- SG Brain: Normative ageing brain template CSVD & Neurodegeneration

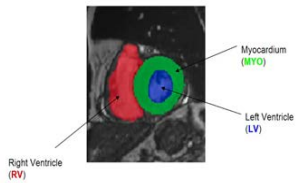


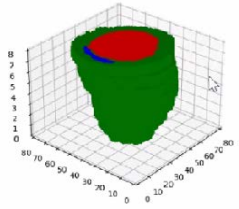


National Heart Centre Singapore SingHealth

- Characterization of Cardiovascular changes in SG population.

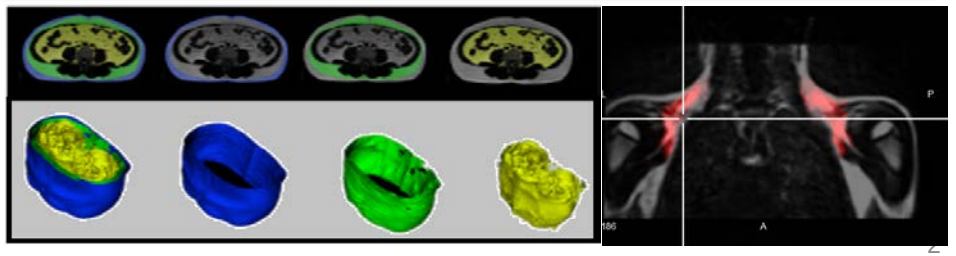




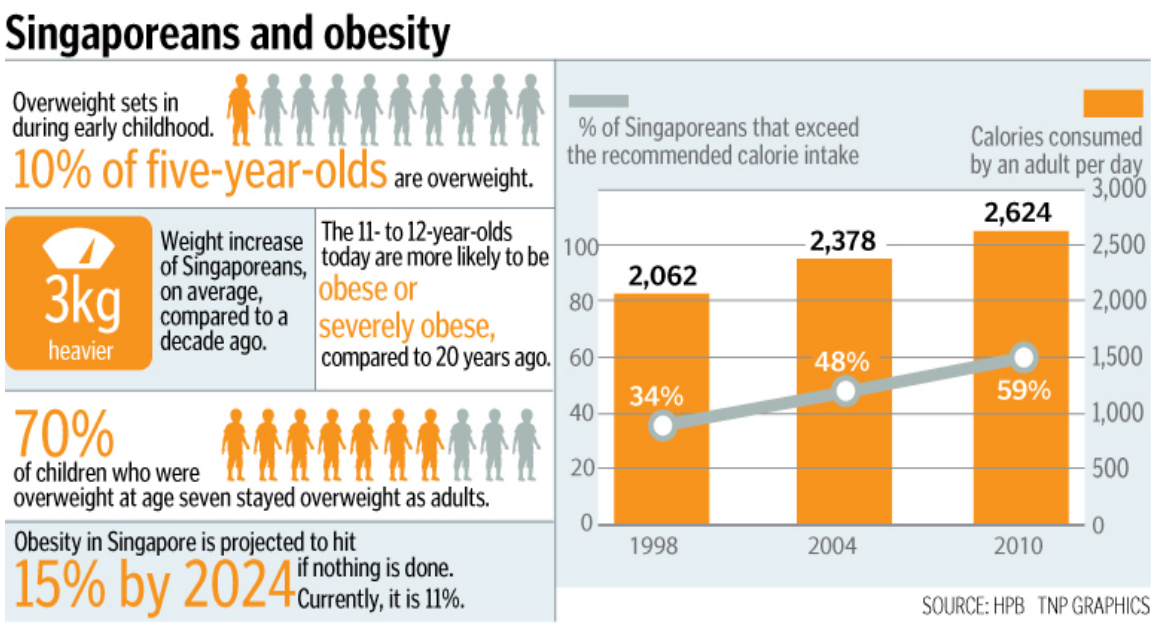


Tan Tock Seng Hospital National Healthcare Group · Singapore Institute for Clinical Sciences

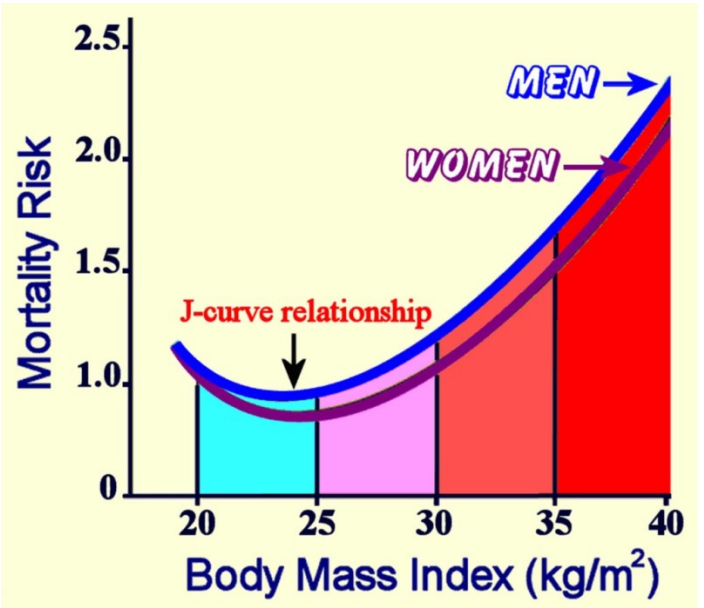
- Brown Adipose tissue in Children
- Geriatric cohort study - Body composition / Sarcopenia



Obesity & Risk Factors



Health Risks &
Burden on Healthcare



Kyrou I, Randeva HS, Tsigos C, et al. Clinical Problems Caused by Obesity. [Updated 2018 Jan 11]. In: Feingold KR, Anawalt B, Boyce A, et al., editors. E

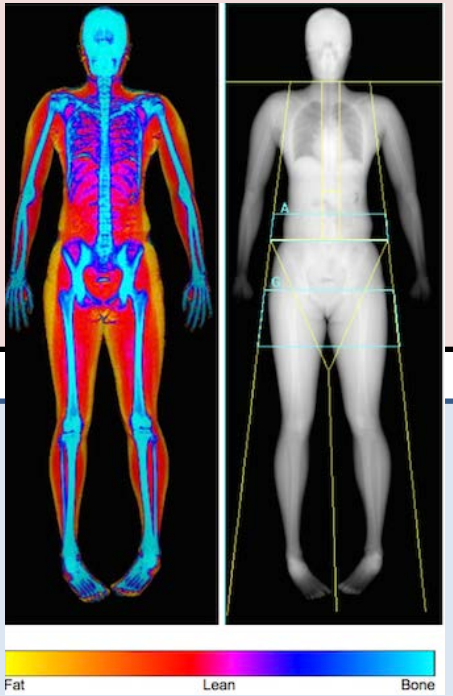
CREATING GROWTH, ENHANCING LIVES

Obesity Management

Singapore have declared war on obesity.

Understanding the phenotypes & genotypes of obesity is crucial for profiling & management of the condition.

Quantification of obesity helps
- monitoring the changes due to interventions,
- visualization of fat compartments,
- inter-ethnicity differences,
- inter – and intra-subject changes etc. which are part of the large cohort studies.



BMI is not an ideal metric – Same BMI subjects have different fat distribution

- Imaging – CT / MR best way to quantitate – Radiation / Expensive
- Different fat compartments influence risks differently.
- Single location (L3) vs L1 – L5 profiling – Variability in estimation
- MR – Breath hold sequence, issues with motion, variability in data – Anatomical / person, fat /water swaps
- Manual segmentation is time consuming & laborious

Sarcopenic obesity is **a new class of obesity in older adults in which low skeletal muscle mass is coupled with high levels of adiposity**.

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CAFT: a deep learning-based comprehensive abdominal fat analysis tool for large cohort studies

Research Article | Published: 02 August 2021

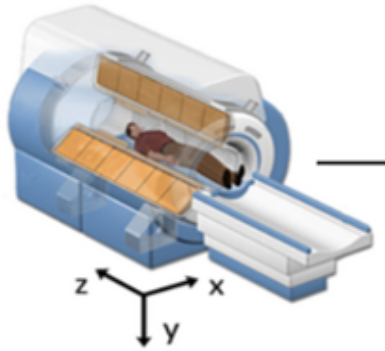
CAFT: a deep learning-based comprehensive abdominal fat analysis tool for large cohort studies

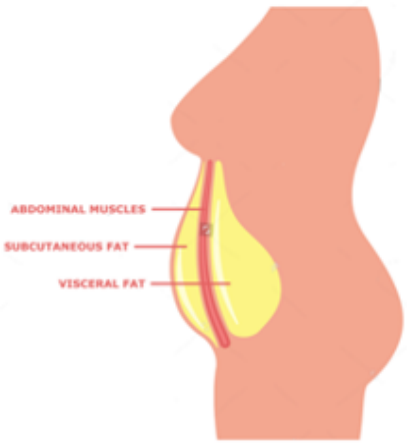
Prakash KN Bhanu, Channarayapatna Srinivas Arvind, Ling Yun Yeow, Wen Xiang Chen, Wee Shiong Lim & Cher Heng Tan

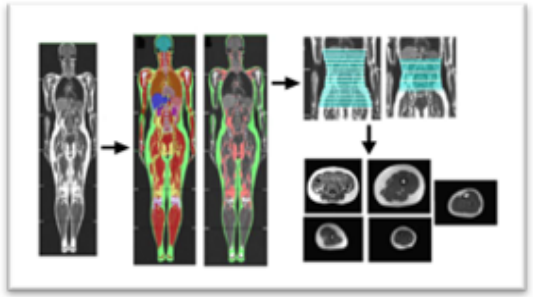
Magnetic Resonance Materials in Physics, Biology and Medicine (2021) | Cite this article

Agency for Science, Technology and Research SINGAPORE

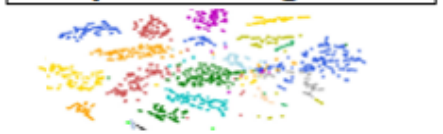
Tan Tock Seng HOSPITAL
National Healthcare Group

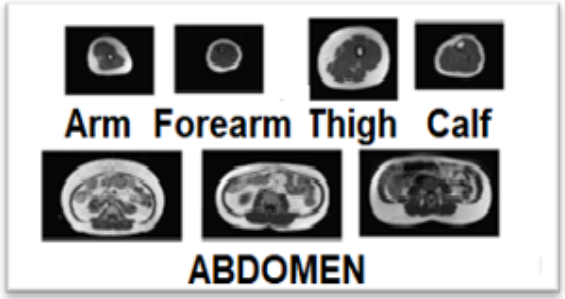






Deep Learning Model

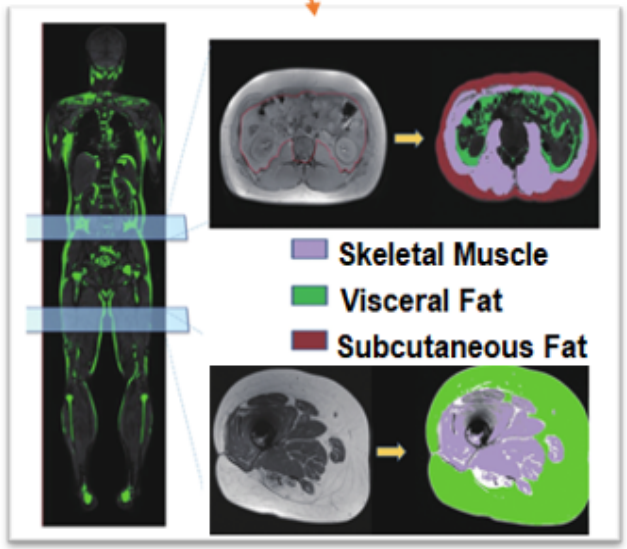




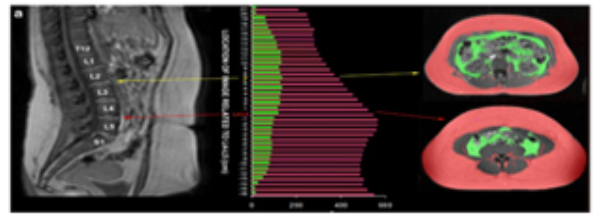
Classification

Fat Region Segment

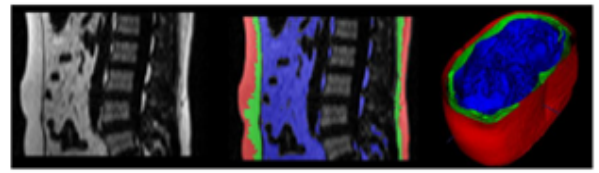
Subcutaneous Fat
Visceral Fat
Skeletal Muscle



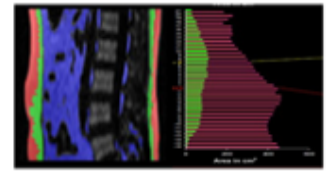
Segmentation

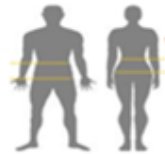


Fat Distribution Analysis



Fat Volume Analysis





Waist To Hip Analysis

Volume Calculation

- **End To End Human Metabolic Fat Analysis Framework**
- **Automatic Fat Analysis Report Generation**
- **Total Assessment Time:** 5 mins per patient

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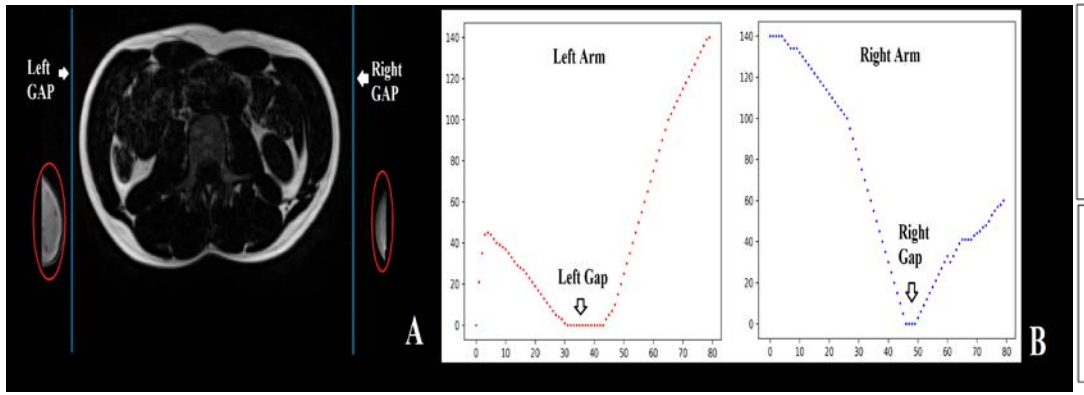
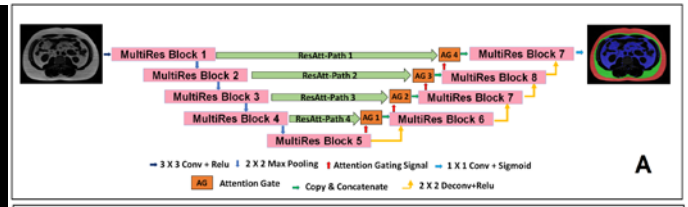
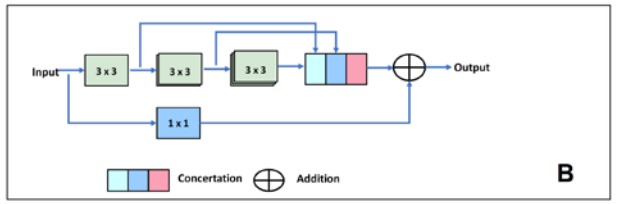
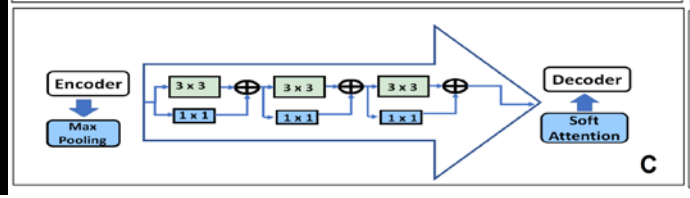
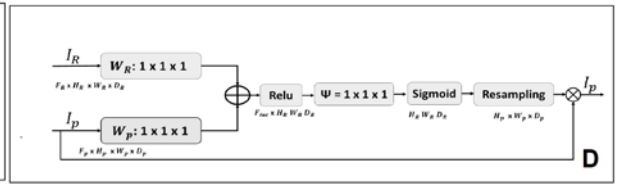
Per-Processing – Arm Removal







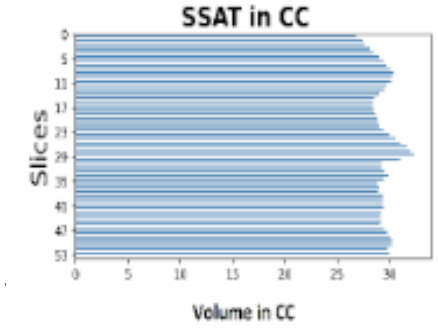


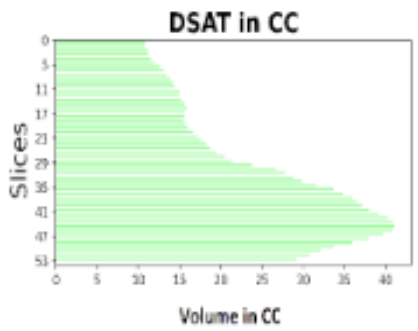


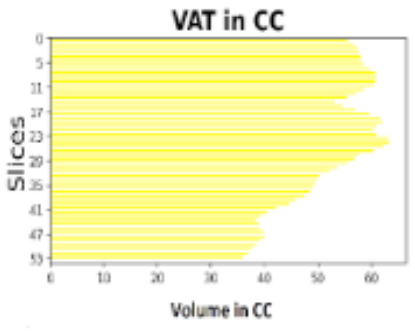
Proposed MultiRes-Attention

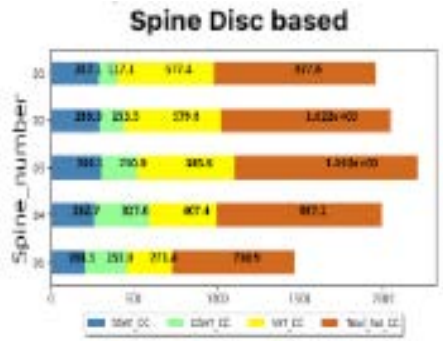
Post-Processing – Spine Region Extraction

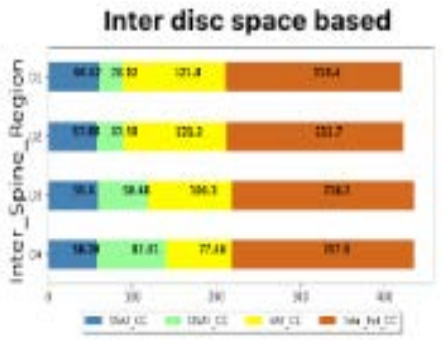
Abdominal Fat Quantification



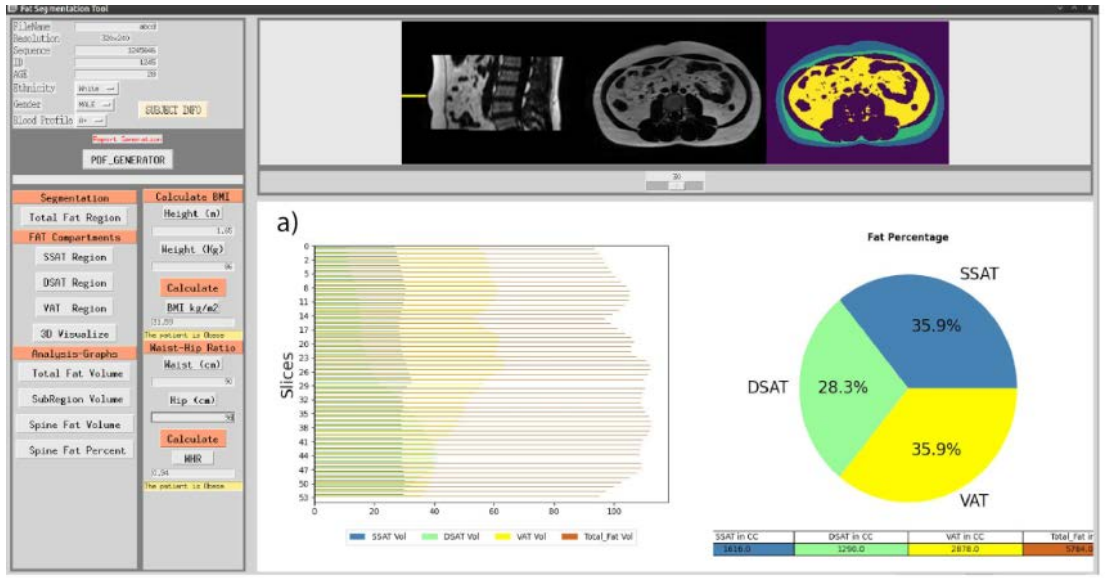




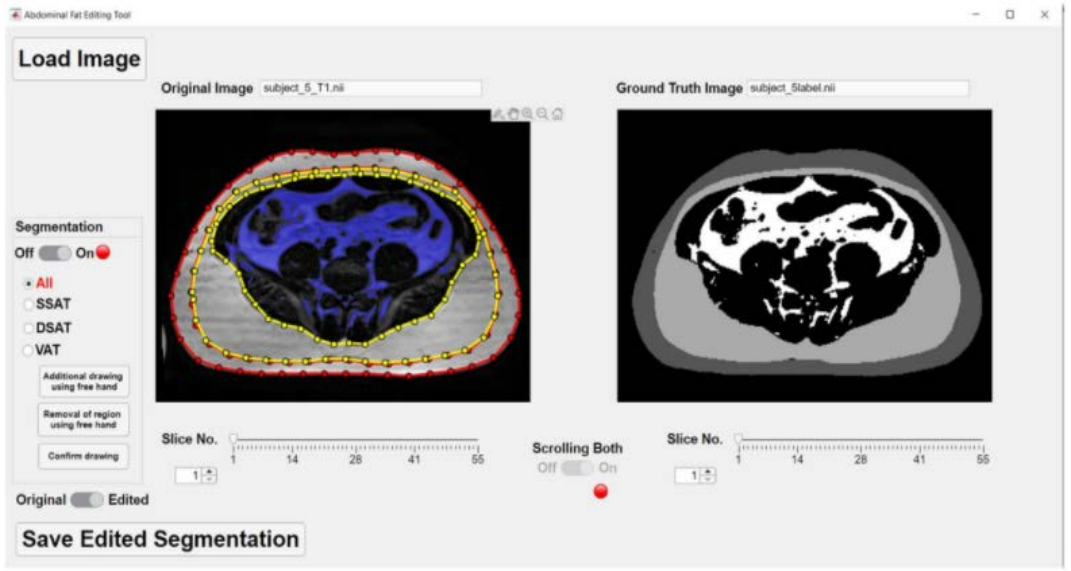




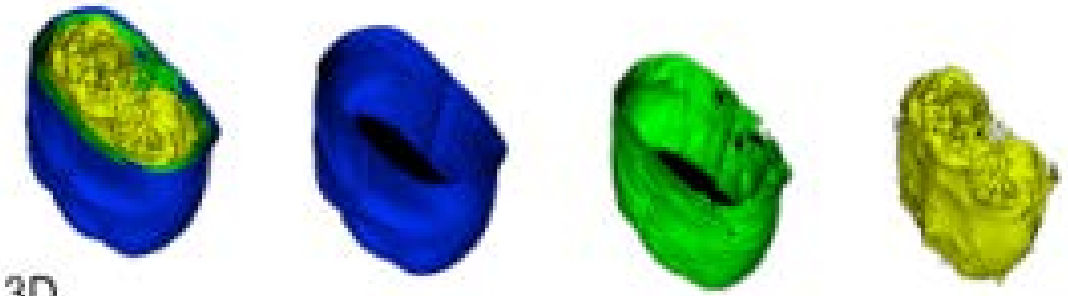
FAT Segmentation & Analysis Tool



Correction Tool



2D



3D

8

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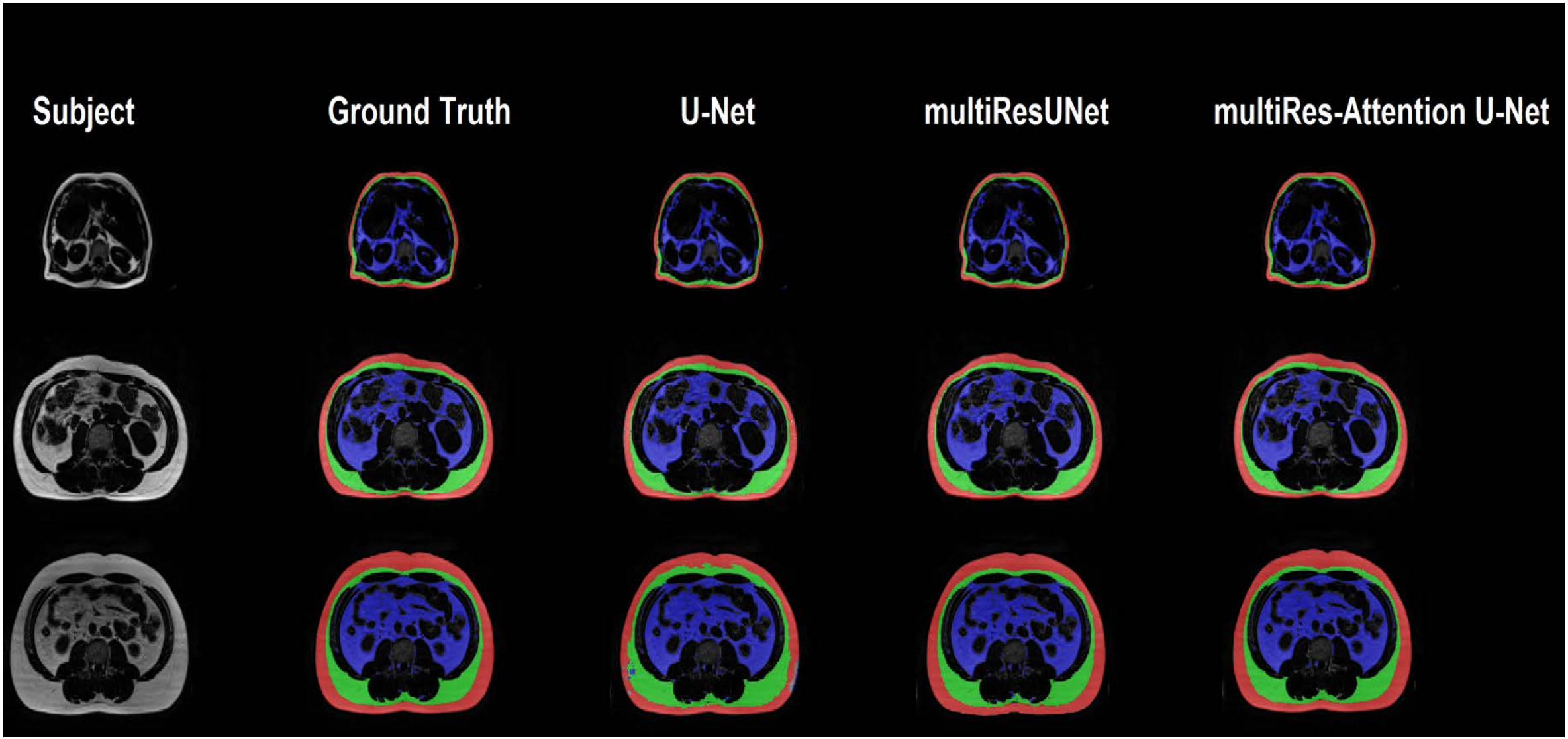
MultiRes-Attention Deep Learning Approach for Optimal Segmentation of Abdominal Adipose Tissue Compartments



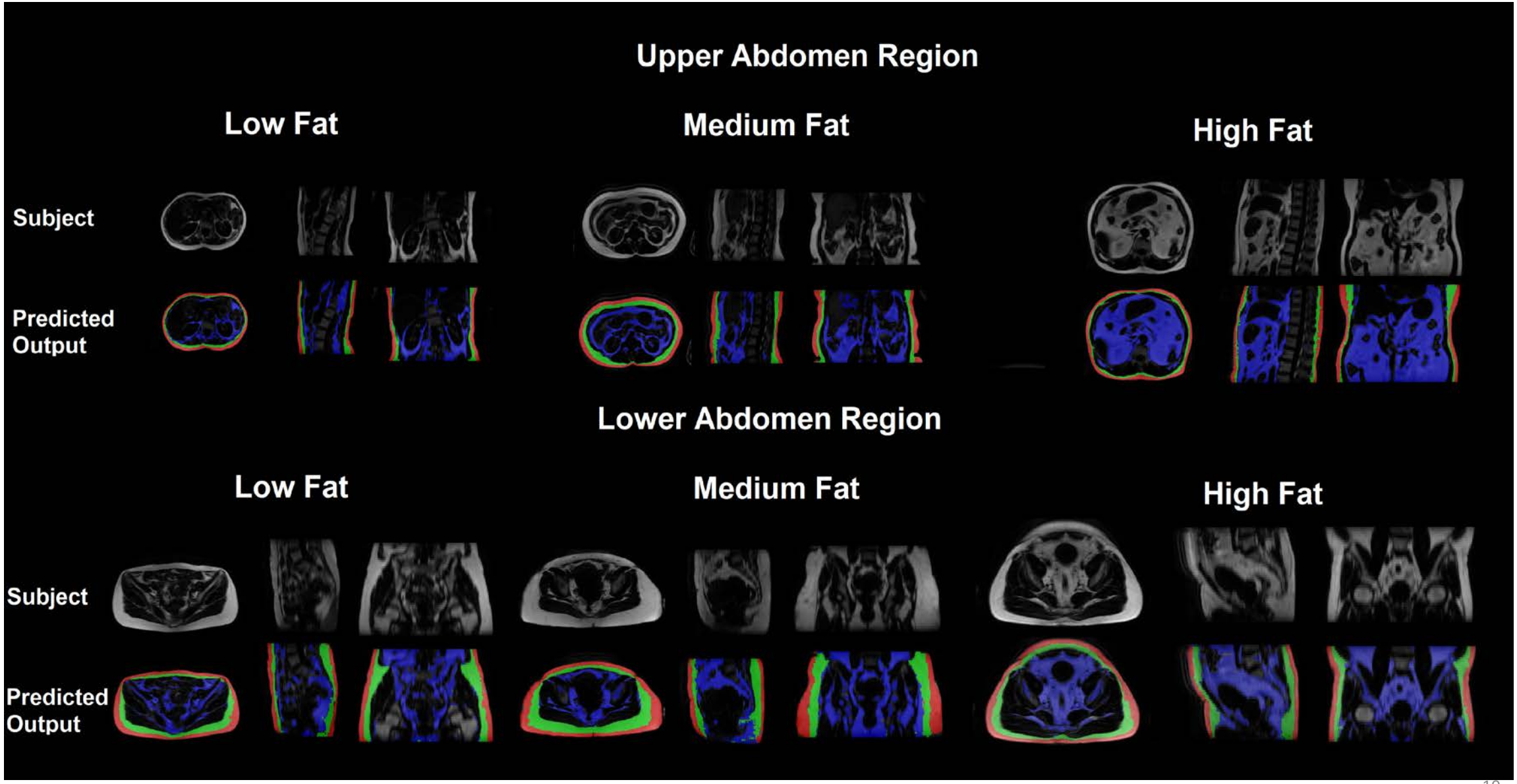
Sample Output of the proposed deep learning architecture and comparison

CREATING GROWTH, ENHANCING LIVES

9

Under Review- Confidential

MultiRes-Attention Deep Learning Approach for Optimal Segmentation of Abdominal Adipose Tissue Compartments

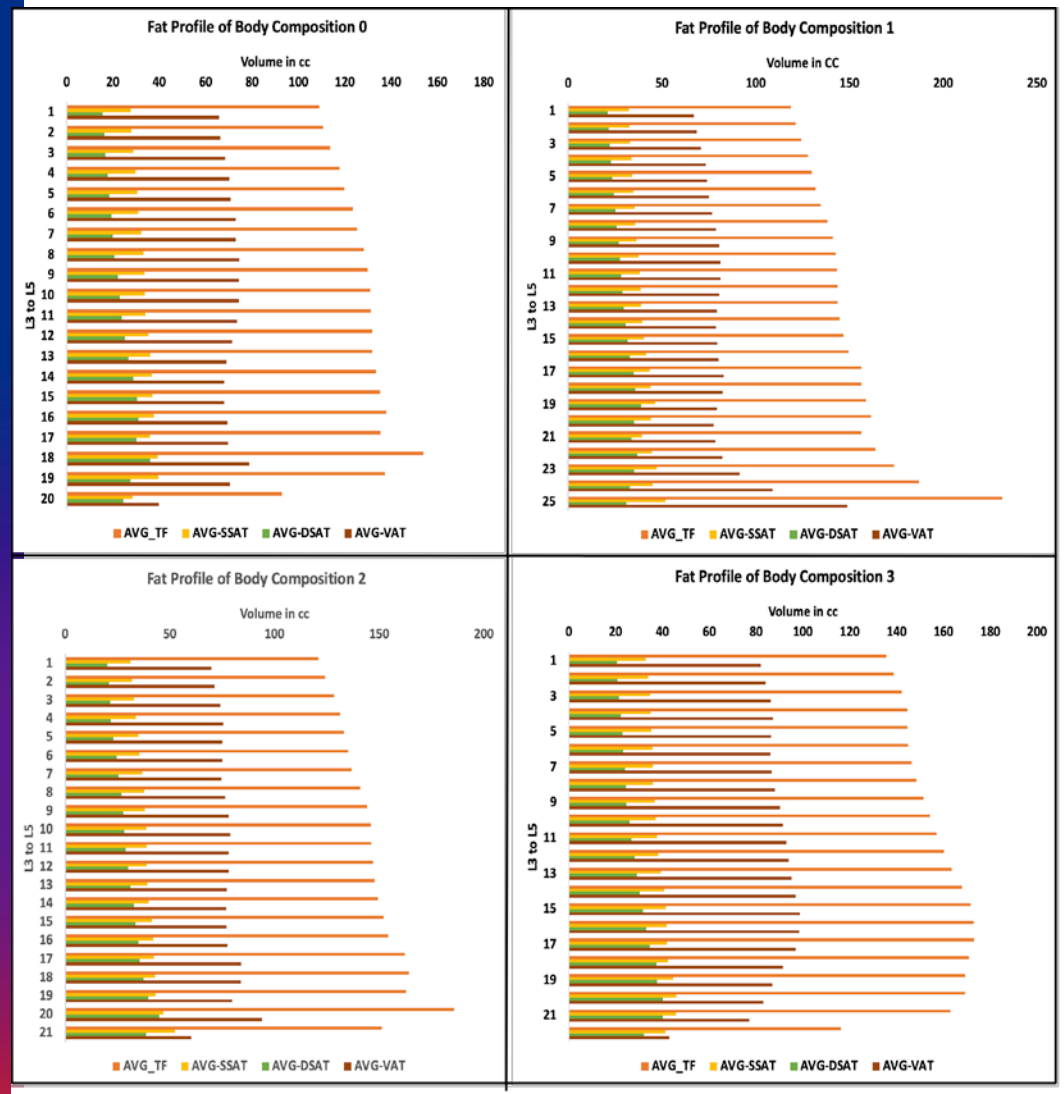


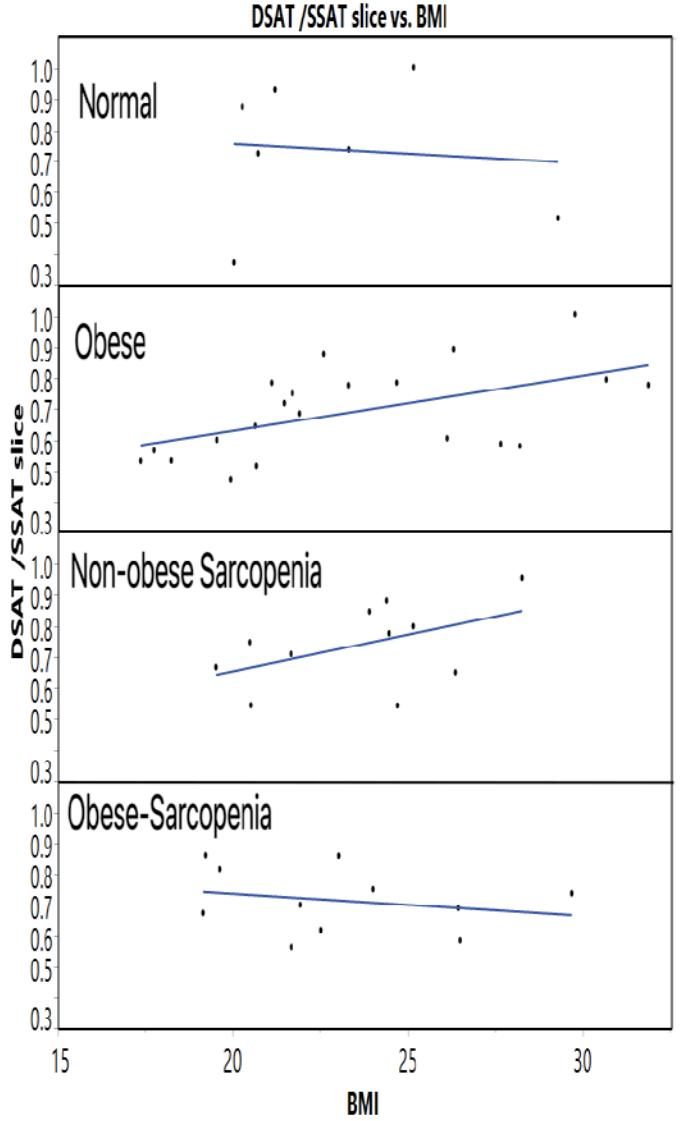
Unseen - Upper & lower abdomen scans with different resolution

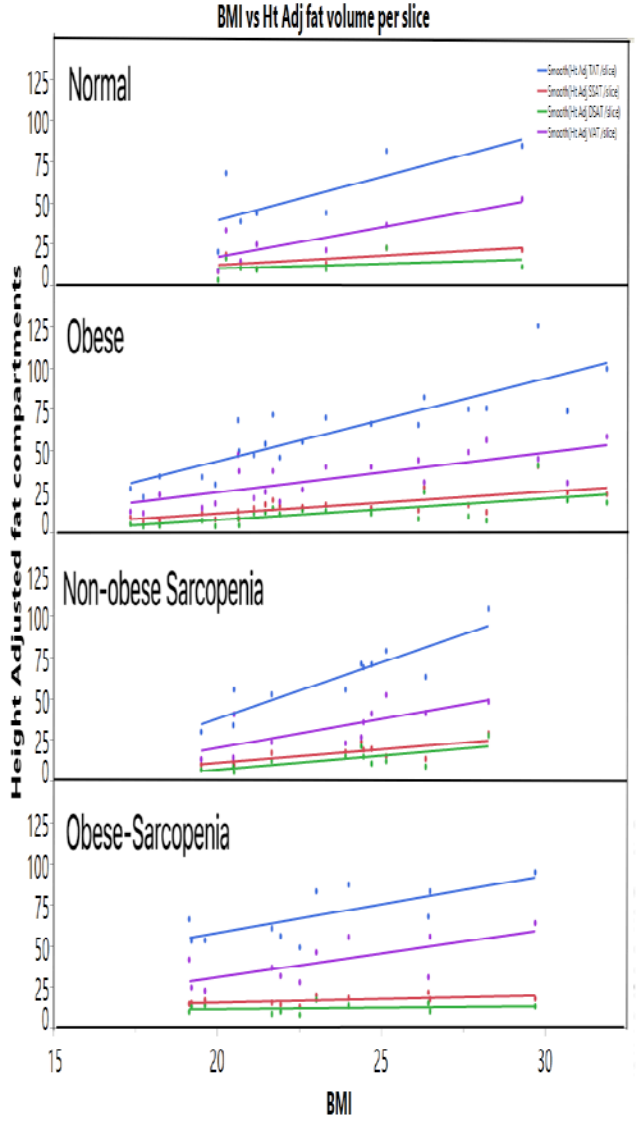
Under Review- Confidential

CREATING GROWTH, ENHANCING LIVES

Clinical Assessment Framework for Sarcopenic Obesity profiling in SG population







Study extended to include other imaging regions – Upper / Lower abdomen, Thigh / Calf and Arm

CREATING GROWTH, ENHANCING LIVES

Background - Psychiatric disorders

9 in 10 Singaporeans still struggling with their mental health 1 year into the pandemic, men and younger adults most worried

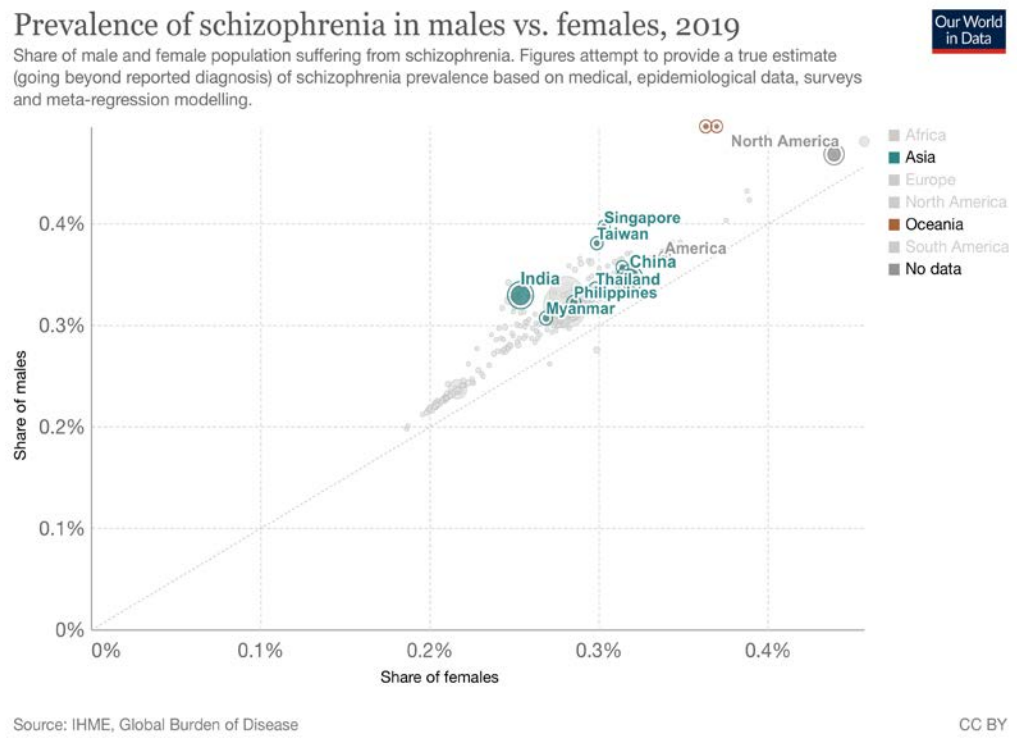
Singapore, 15 April 2021 – AIA Singapore today announced findings from a new study on the state of Singaporeans' health at the one-year mark since COVID-19 was declared a pandemic. It revealed that fears over income loss and job instability caused 91% of respondents to report declines in their mental health. Around 60% of respondents are also deeply concerned about the added burden of other critical illness diagnosis such as cancer.

1 in 43 people in Singapore had a diagnosis of schizophrenia or other psychotic disorders in their lifetime

The lifetime prevalence of schizophrenia and other psychotic disorders in Singapore was 2.3%. Of this, about one third of the population (0.86% or 1 in 116 persons) had a diagnosis of schizophrenia at some point in their lives. This makes schizophrenia the most common among psychotic disorders here. While the treatment gap of

Prevalence of poor mental health among Singapore residents 'remained stable' in 2020: MOH survey

Younger adults aged 18 to 29 had the highest proportion with poor mental health in Singapore.



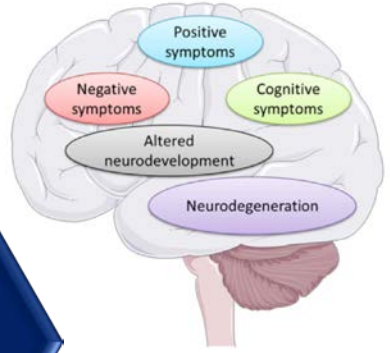
https://www.channelnewsasia.com/singapore/poor-mental-health-stable-2020-national-health-young-adults-2322476

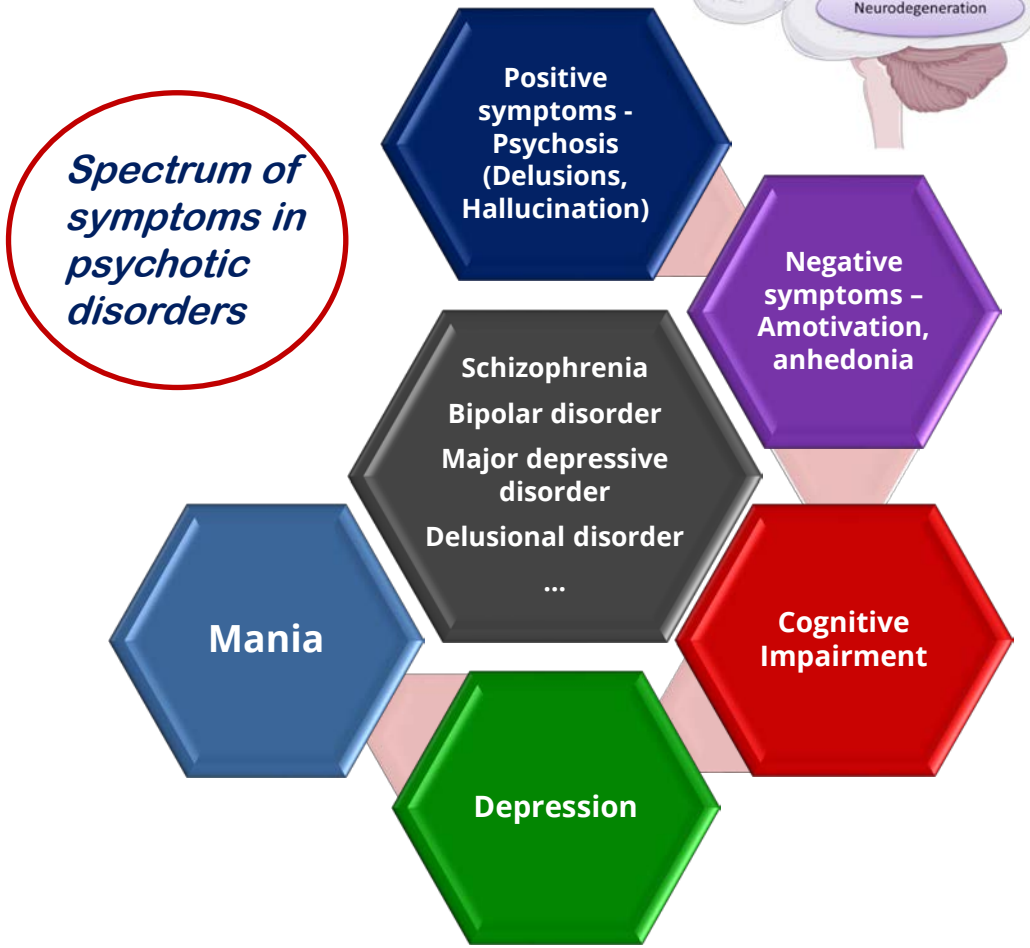
https://www.imh.com.sg/Documents/research-announcements/21%20May%202021_%20Prevalence%20of%20Schizophrenia%20and%20Other%20Psychotic%20Disorders%20in%20Singapore.pdf

CREATING GROWTH, ENHANCING LIVES

Background - Psychiatric disorders

- Complex set of disorders with
  - overlapping symptoms,
  - long duration of illness preceded by
  - long prodromal phase
- Lack of reliable diagnostic markers
- Differential diagnosis and stratification of illness course or response
  - Remission vs Non-remission
  - Deficit /Non-Deficit
  - Individual patient level differences unclear





Schizophrenia is a mental disorder characterized by a distorted perception of reality.

CREATING GROWTH, ENHANCING LIVES

Methodology – Data Overview

Healthy controls	80
Schizophrenia	160
Bipolar disorder	42
Major depressive disorders	2

INSTITUTE of MENTAL HEALTH
Loving Hearts, Beautiful Minds

Diagnosis was made for all patients by psychiatrists based

- clinical history,
- existing medical records,
- structured clinical interview for DSM-IV,
- Symptoms (PANSS),
- Functioning (GAF),
- Quality of life (WHOQOL-BREF),
- Cognition, read, write (BACS, WRAT3),
- Mania (YMRS)

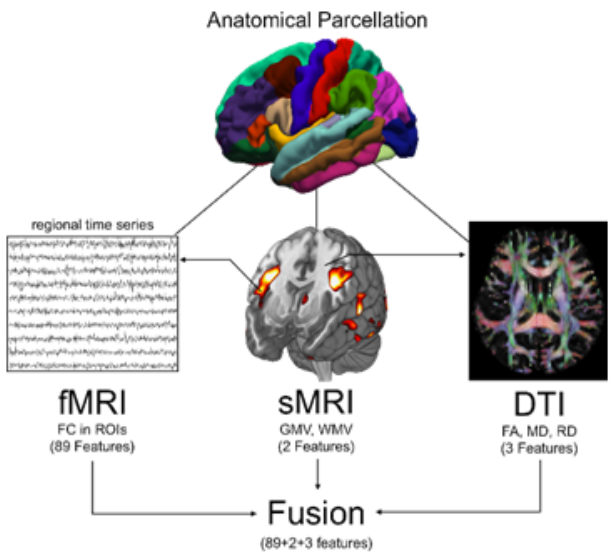
3T Philips Achieva Scanner
Parallel imaging (SENSE).
Axial T1 MPRAGE
256 x 256; 0.8984 x 0.8984 x 1 mm^3,
at least 180 slices covering the brain.

Psychiatric subjects had no history of any significant neurological illness such as seizure disorder, head trauma or cerebrovascular accident for the patients.

HC were free of any Axis- I psychiatric disorders, had no history of any major neurological, medical illnesses, substance abuse or psychotropic medication use.

CREATING GROWTH, ENHANCING LIVES

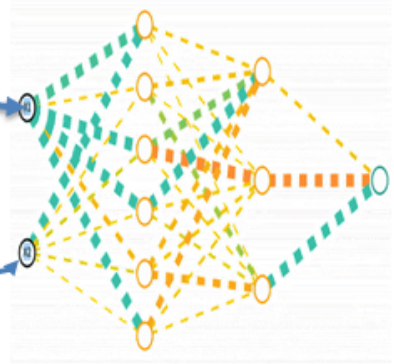
Methodology – Processing



Non-imaging data
Psychometric tests
Non-identifiable patient information
Patient illness history

Co-registration,
Brain region extraction

Feature extraction



Data processing Algorithms (machine learning/ deep learning)

- Classification of remission in patients with schizophrenia
- Investigation of multimodal imaging biomarkers for classification of remission status
- Alterations in morphology and connectivity patterns with longitudinal progression of schizophrenia
- Investigation and corroboration of fMRI with observed changes in structural and diffusion MRI in Schizophrenia
- Alterations in morphology and connectivity patterns in Bipolar Disorder
- Psychometric tests scores comparison with alterations in neuroimaging data

NSCC High performance computing (DGX, ASPIRE)

Processing time reduced from 4 months to < 20 days

Automating pipelines **Processing time**

Current results derived are from pure data science perspective.

"From observation to causation"

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Methodology – Structural Data Processing

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Freesurfer 6.0.0 software

- Inhomogeneity correction
- Skull stripping
- Atlas registration
- Segmentation
- Extraction of statistics

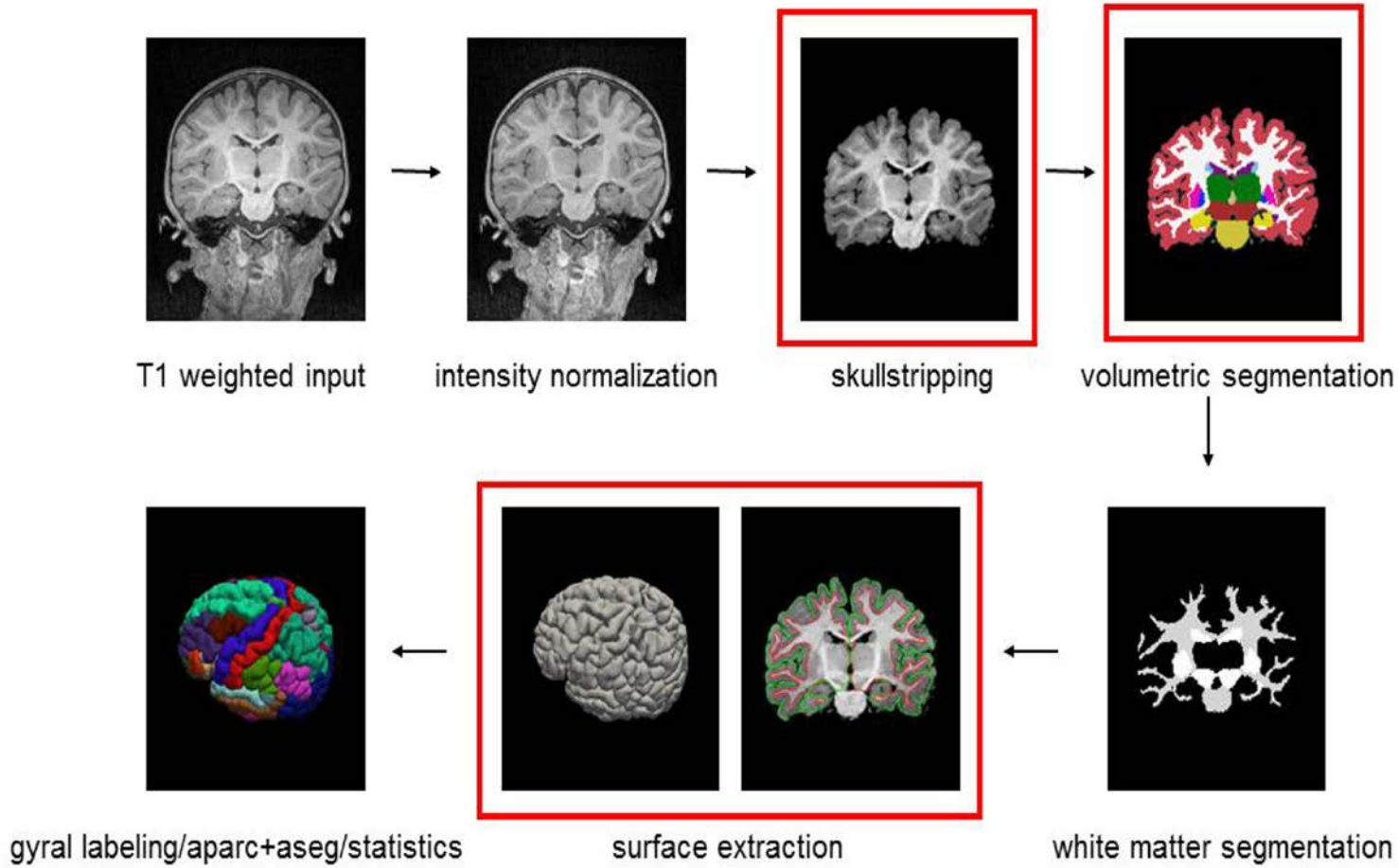
Subcortical segmentation

Gaussian Classifier atlas

Cortical parcellation

Desikan-Killiany atlas

55 subcortical volume,
71 cortical volume,
73 cortical surface area
71 cortical mean curvature
73 cortical thickness features



Methodology – Structural /Psychometric scores data processing

Classification Methods

- Discriminant Analysis
- Embedded Classifiers
- Neural Nets
- Decision trees

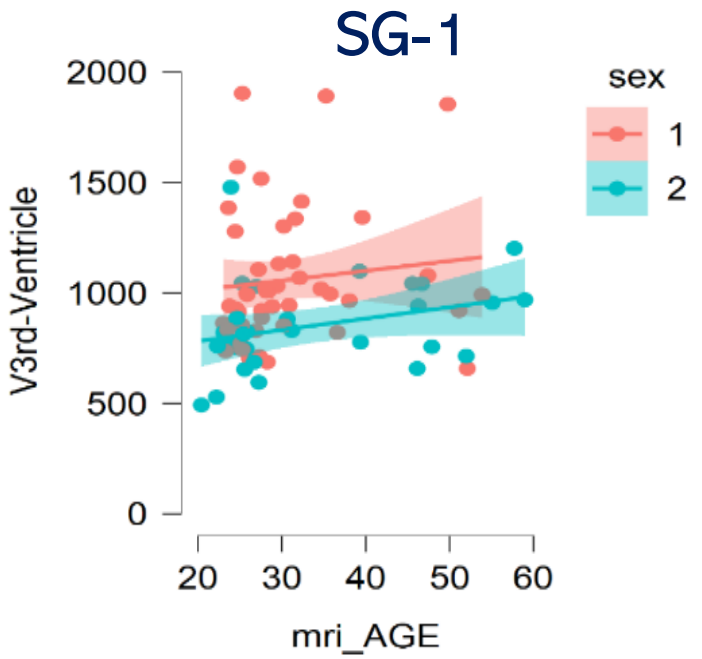
Psychometric score analysis

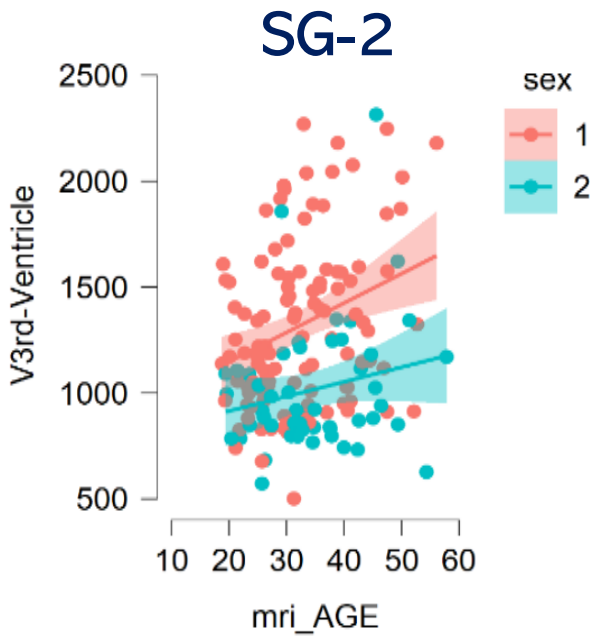
- Psychometric scores based classification
- Logistic Regression,
- SVM,
- KNN,
- Random Forests,
- Gradient Booting methods

- Identify the most relevant test/s – improve accuracy, save time & cost

Subtyping of SCZ cohort

- Effects of
  - Age
  - Sex
  - CPZ
  - Psychosis duration
  - Education
  - Occupation
- Analysis of subtypes in SCZ
- Remission and Deficit correlation studies





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