

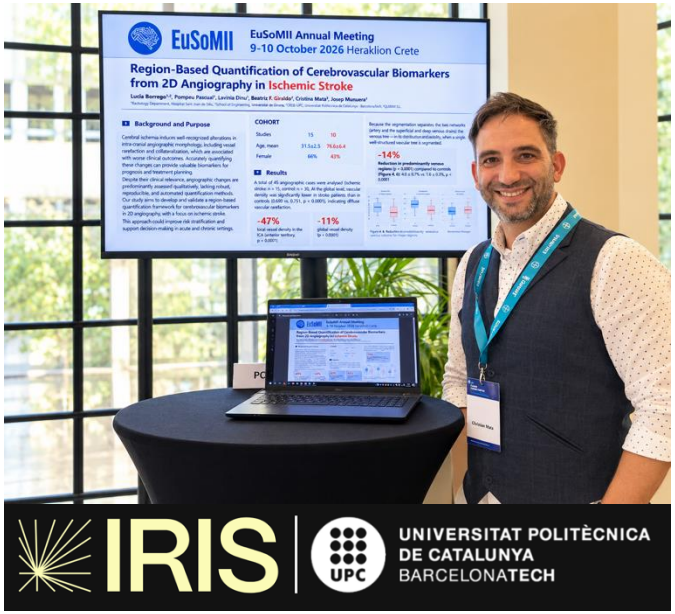
SJD Sant Joan de Déu Barcelona · Hospital

PeCIC

Pediatric Computational Imaging Center

SJD Sant Joan de Déu Institut de Recerca

Christian Mata Miquel
christian.mata@upc.edu



Institute for Research and Innovation in Health (IRIS)

Teaching

UPC 10 anys EEBE

ESAII Department

Course instruction

- ☐ Informatics
- ☐ Automatic control
- ☐ Biomedical Image Processing
- ☐ Computer Vision
- ☐ Data Analysis & Pattern Recognition

Course coordinator

- ☐ Biomedical Image Processing (Biomedical Engineering)
- ☐ Data Analysis & Pattern Recognition (Master's degree in Interdisciplinary and Innovative Engineering)

Academic coordinator

- ☐ Erasmus Mundus master's degree in Sustainable Systems Engineering **(EMSSE)**

Research

BCoMSC

Computational Biology and Complex Systems

Universitat Politècnica de Catalunya

SJD Sant Joan de Déu Barcelona · Hospital

Scientific Society

BIOMED

Sociedad Española de Inteligencia Artificial en Biomedicina

Board of Directors

- ☐ Activities and Events Manager

Hospital Sant Joan de Déu





Esplugues de Llobregat

(Barcelona)

SJD Sant Joan de Déu
Barcelona · Hospital

350.000
Patients/year

Activity



244.731
Outpatient visits

25.465
Discharges

3.140
Births

121.957
Emergencies

Resources



1.701
Staff members

300
beds

13
Operating rooms

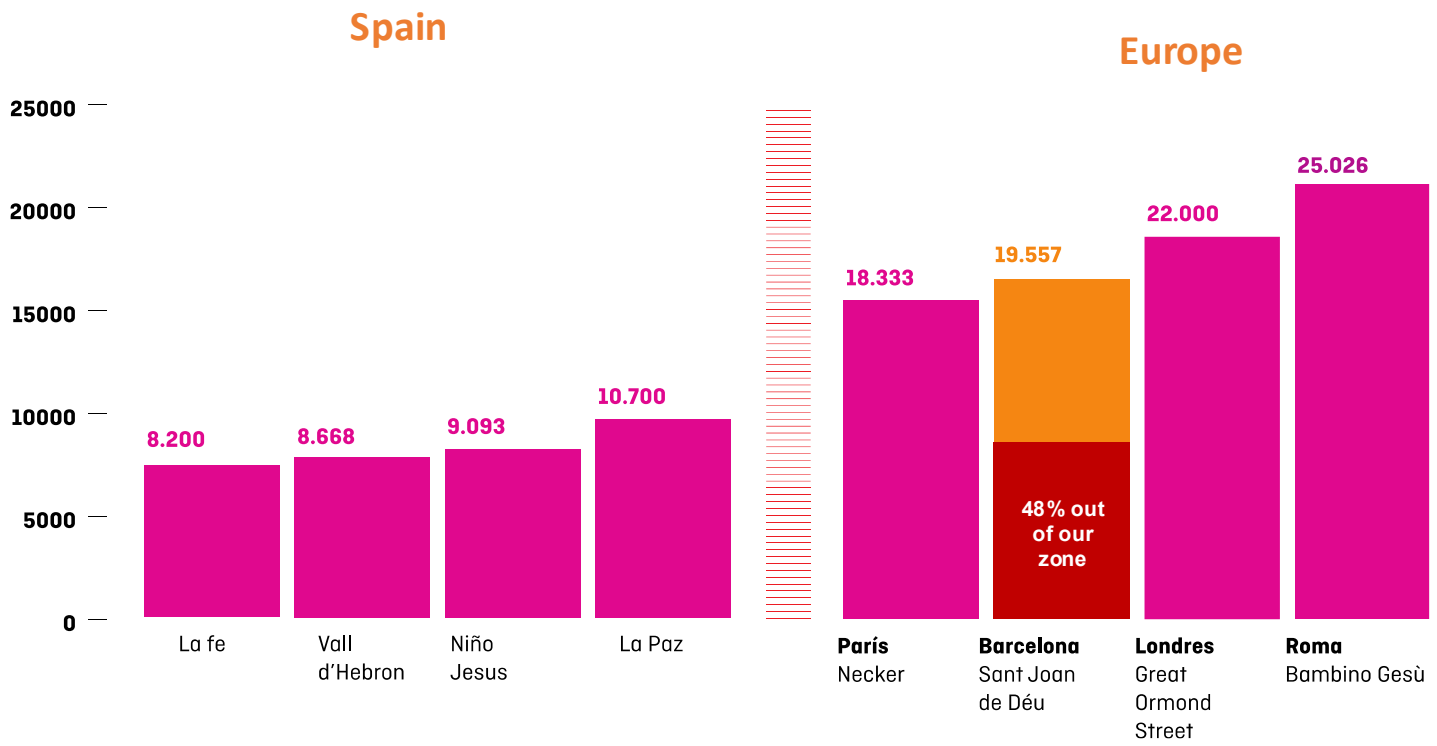
Pediatric Cancer Center Barcelona (PCCB)



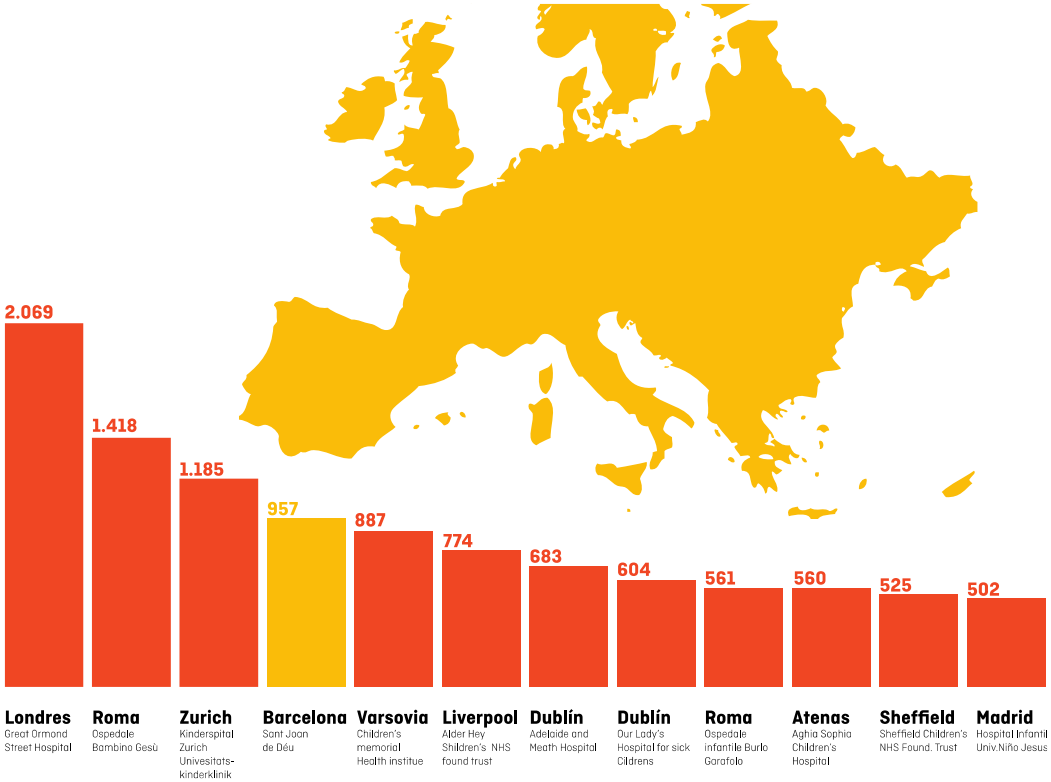




Pediatric discharges

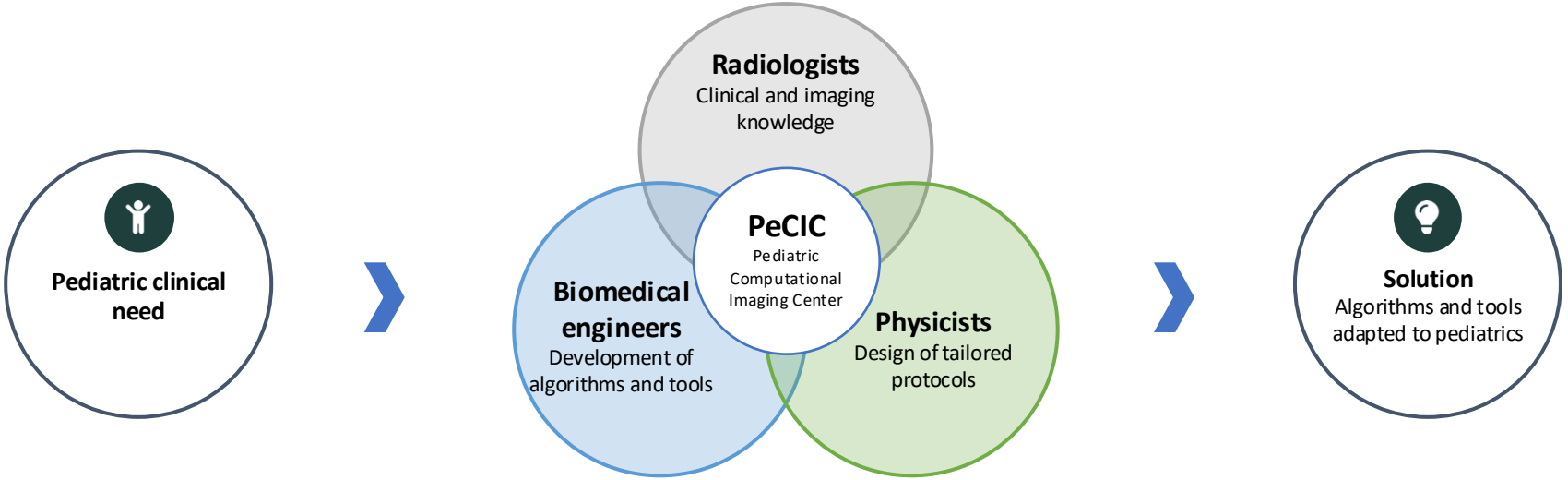


Scientific Impact Factor



The PeCIC: Pediatric Computational Imaging Center

The PeCIC was created to address the specific challenges of medical image analysis in the pediatric population.



Its goal is to apply advanced imaging techniques and artificial intelligence to develop algorithms and tools adapted to clinical needs, driving research, the extraction of quantitative biomarkers and clinical innovation.



2020

Sant Joan de Déu Barcelona · Hospital

Dr. Josep Munuera del Cerro

Dr. Arnau Valls

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Dr. Raúl Benítez

Dr. Christian Mata




Dr. Emili Inarejos Dr. Jordi Muchart

Radiologist




Dr. Arnau Valls Dr. Christian Mata

Coordinators





Dr. Christian Stephan-Otto Júlia Romagosa Violeta Perez

Engineers

DxI

R&D

Pediatric Computational Imaging Center = DxI + R&D

2024

SJD Sant Joan de Déu Barcelona · Hospital

UPC UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Pe C I C

Pediatric Computational Imaging Center

3D4H
3D for health

SJD

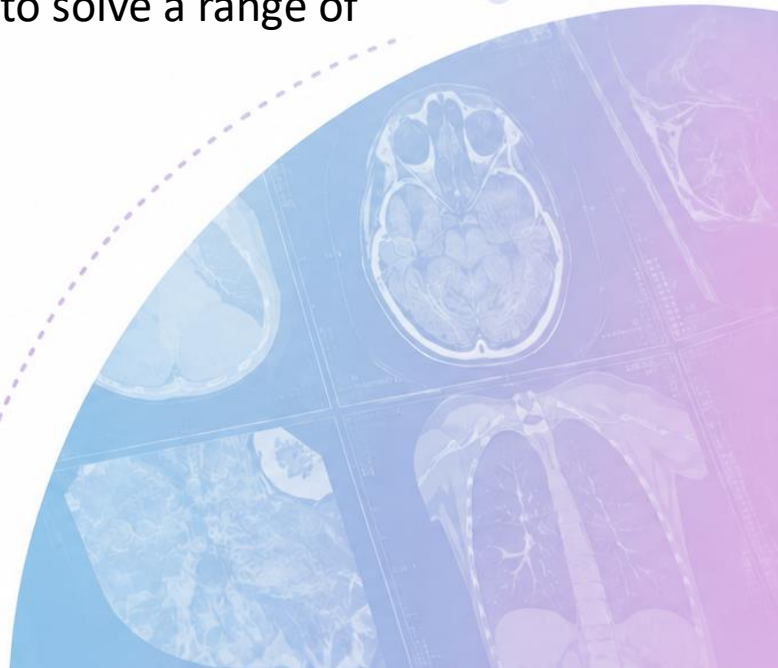
SJD Sant Joan de Déu Institut de Recerca



What do we do?

The Pediatric Computational Imaging Center (PeCIC) brings together specialists from several clinical and scientific-technical disciplines to solve a range of medical imaging challenges in the pediatric field.

Support for research or clinical projects that require advanced medical image analysis.



Challenges in pediatrics

Limited data

Pediatric cohorts tend to be small, which makes it harder to train and validate robust models.

High anatomical variability by age

Growth and neurodevelopment introduce continuous anatomical changes.

Rare diseases

Low-prevalence conditions make diagnosis and study more difficult.

Acquisition variability

Motion, heterogeneity between centers and different protocols produce images that are harder to compare and analyze.



Advice on the design of medical imaging projects



Implementation of tailored research protocols



Medical imaging database management



Medical image post-processing



Development of custom algorithms and analysis



Exploration of new imaging biomarkers



Results analysis and structured reports

SJD Sant Joan de Déu Barcelona · Hospital

Research projects

Case 1

Advanced brain quantification in rare diseases



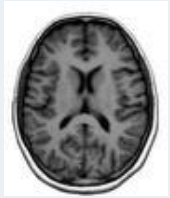


Case 1 | Automating echocardiography processing

Cohorts
SYNGAP1 (n = 28) · GRIN (n = 22) · STXBP1 (n = 10)

Neurodevelopmental diseases caused by mutations in synaptic genes

1 Brain MRI



Structural T1 image
Pediatric cohort

2 Automatic segmentation

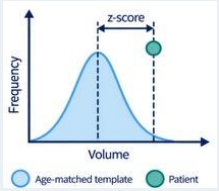


Robust to different protocols, image qualities and ages

3 Extraction of regional volumes

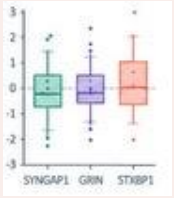
Frontal, temporal, parietal, occipital, hippocampus, amygdala, thalamus

4 Age normalization



Comparison with age-matched normative templates

5 Comparison between genetic groups

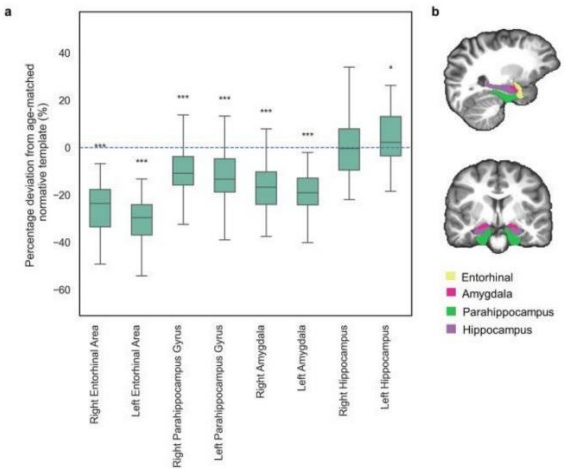


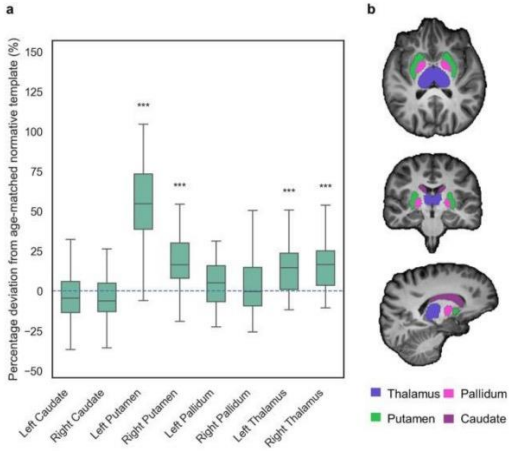
Volume (z-score) by gene group

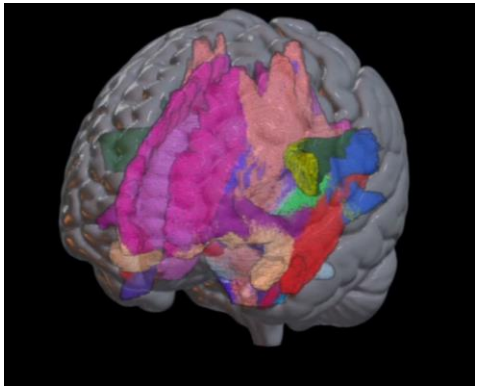
6 Correlation with clinical variables

- Cognitive function
- Motor function
- Neuropsychiatric symptoms
- Clinical scales and phenotype

Case 1 | Automating echocardiography processing







Quantification reveals patterns that are not visually evident.
Prospect of use in the longitudinal follow-up of patients.

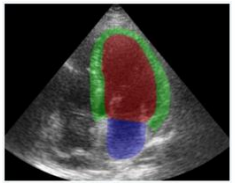
Data Analysis + Image Processing

SJD Sant Joan de Déu Barcelona · Hospital

Research projects

Case 2

Automating echocardiography processing





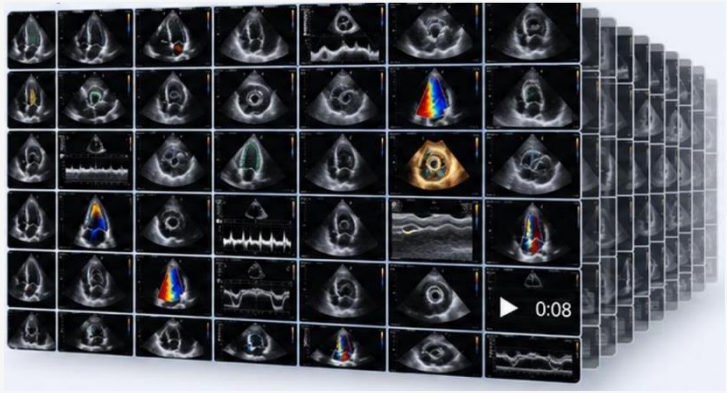
Case 2 | Automating echocardiography processing

- A single study gathers dozens of images and clips from **different views and modalities.**
- Images are not labeled: there is no direct way to know which view it is or how it was acquired.
- For fully automated analysis, the useful image must first be located by hand before anything is measured: a **slow** and **poorly** reproducible step.

Objective: automate the processing to analyze hundreds or thousands of studies with less manual work.

Hundreds or thousands of echocardiography studies

PACS
2D · Doppler · 3D · Clips



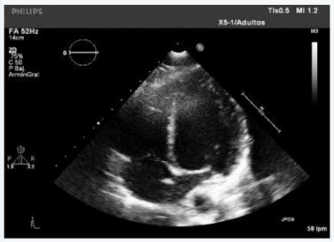
Case 2 | Automating echocardiography processing

1 Raw echocardiographic study



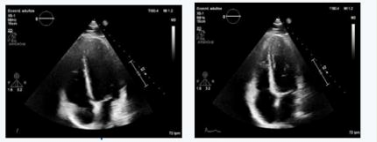
Multiple images per study

2 Automatic view selection



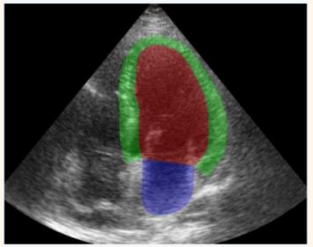
Automatic selection of the apical four-chamber (A4C) view

3 Detection of the moment of interest



Detection of end-diastole and end-systole

4 Automatic segmentation of ED and ES



Left ventricle, myocardial wall and left atrium

Model adaptation

Segmentation models trained on adult populations do not generalize adequately to the pediatric population.
→ **Fine-tuning with pediatric data** to adapt the model to the pediatric clinical context.

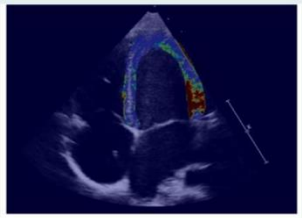
Result

Automated pipeline for view selection, temporal selection and segmentation.

Case 2 | Automating echocardiography processing

Segmentation, radiomics and foundation models to extract clinical value from echocardiography

Radiomics



- Shape
- Intensity
- Texture
- Filters

- Quantitative
- **biomarkers**
- Characterization beyond visual inspection

Foundation models *(in development)*

Adaptation to the pediatric population through fine-tuning and transfer learning.

- Better **generalization**
- Less manual annotation for each new task
- **Robust representations** learned from large collections of echocardiograms
- **One shared base** for several tasks: quantification, classification…

Clinical objective

Classification of patients with cardiac pathology directly from the image and its quantitative representations.

1. Image feature extraction
2. Machine-learning classification
3. Severity grade and type of pathology

Classification

Mild · Moderate · Severe

Pathology: Normal · Cardiomyopathy · Cardiotoxicity · Ventricular dysfunction · …

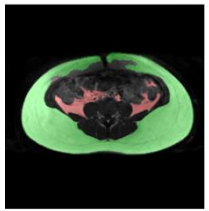
Data Analysis + Image Processing

SJD Sant Joan de Déu Barcelona · Hospital

Research projects

Case 3

Support for clinical trials: SPIOMET4HEALTH



spiomet 4 health



SPIOMET4HEALTH

The **SPIOMET4HEALTH** project is presented as a potential treatment for polycystic ovary syndrome.

Sant Joan de Déu Barcelona · Hospital

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA for Zaky

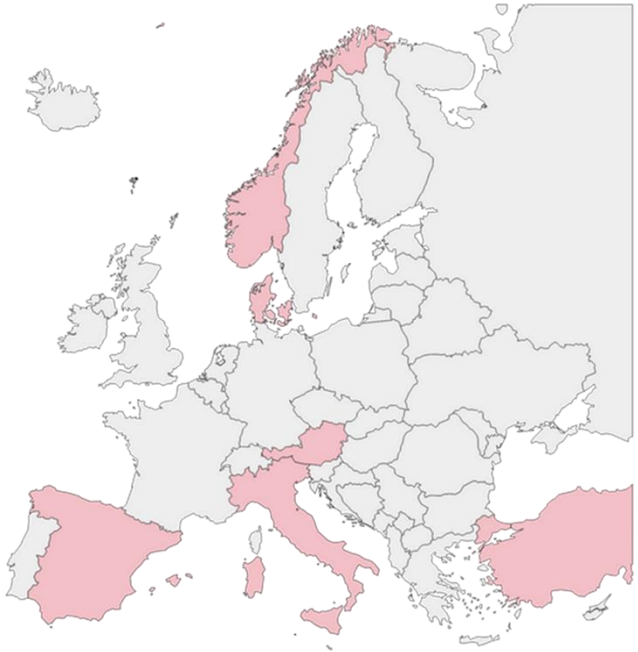
IDIBGi Institut d'Investigació Biomèdica de Girona Dr. Josep Trueta

Med Uni Graz

NTNU

OUH
Odense University Hospital
Svendborg Hospital

T.C. İSTANBUL ÜNİVERSİTESİ 1453



spiomet 4 health



12- 23,9 years old

Abdominal adipose tissue as a window into treatment response in metabolic diseases.

Clinical need

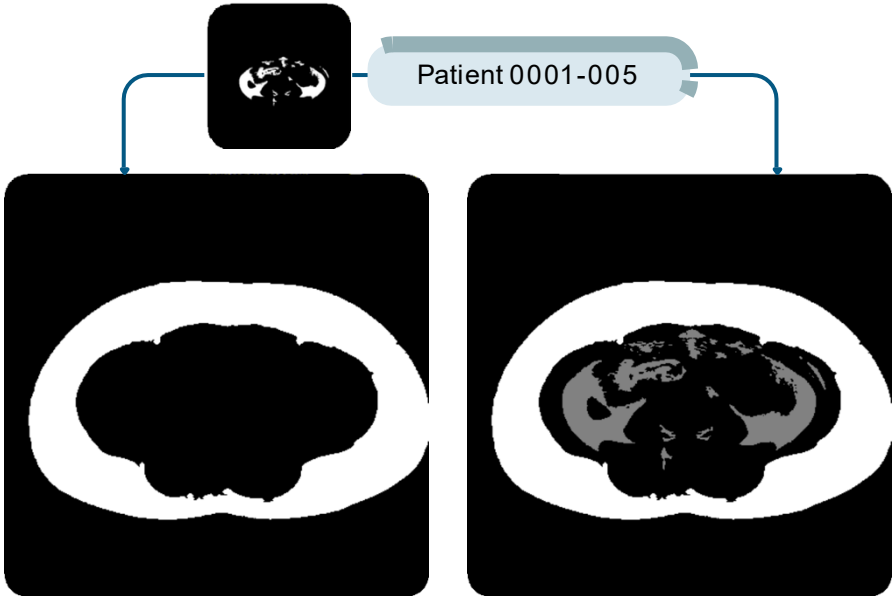
- Automatic quantification of biomarkers to monitor an experimental treatment

Challenges

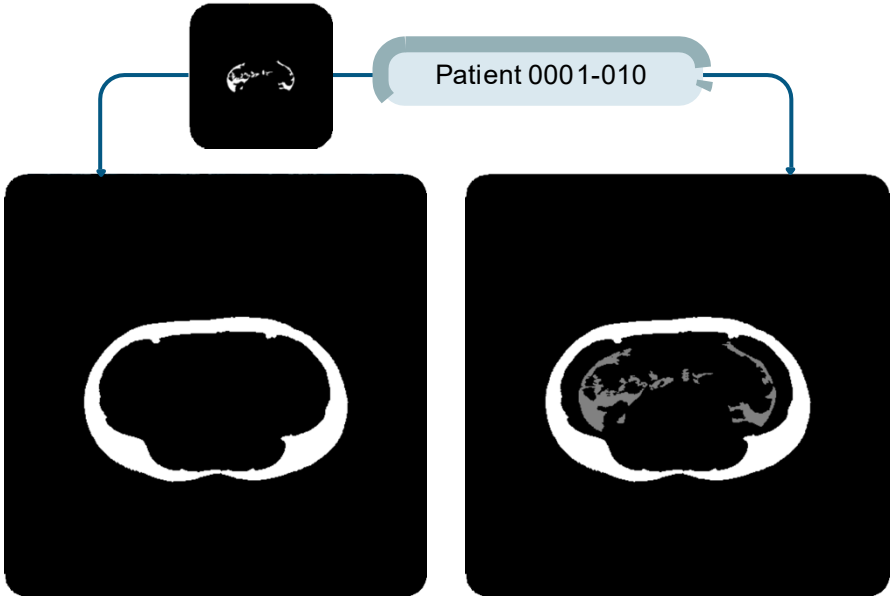
- Generation of ground truth (GT) to develop an automatic algorithm
- Follow-up of a European project
- Wide age range
- Segmentation and quantification of abdominal fat in heterogeneous images (different acquisition protocols)

Objective: segmentation of adipose tissues and quantification of biomarkers.

Visceral and subcutaneous fat segmentation



Overlapped masks Patient 0001-005 [Own source]



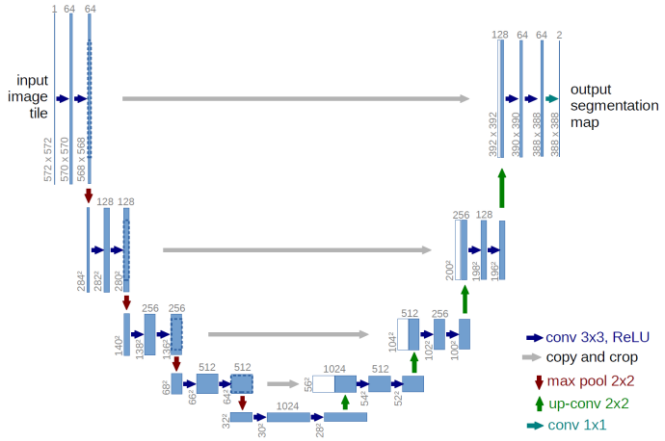
Overlapped masks Patient 0001-010 [Own source]

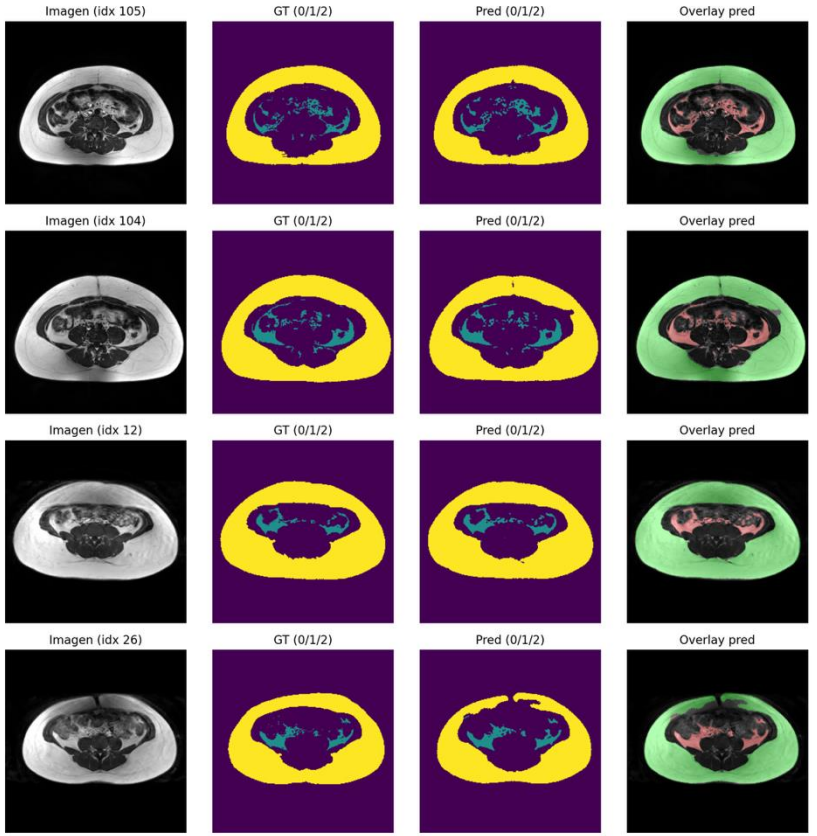
Sant Joan de Déu Barcelona · Hospital



Ground truth

nnUNET segmentation model





Subcutaneous fat DICE: 0.954; Visceral: 0.814

SJD Sant Joan de Déu Barcelona · Hospital

Research projects

Case 4

Retinopathy of prematurity (ROP)





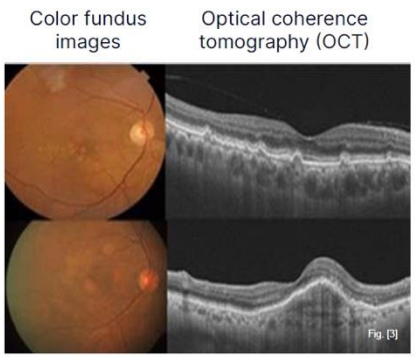
Retinopathy of prematurity (ROP)

Retinal vascular proliferation disorder affecting **premature infants** due to the incomplete development of the retinal blood vessels.

Effects

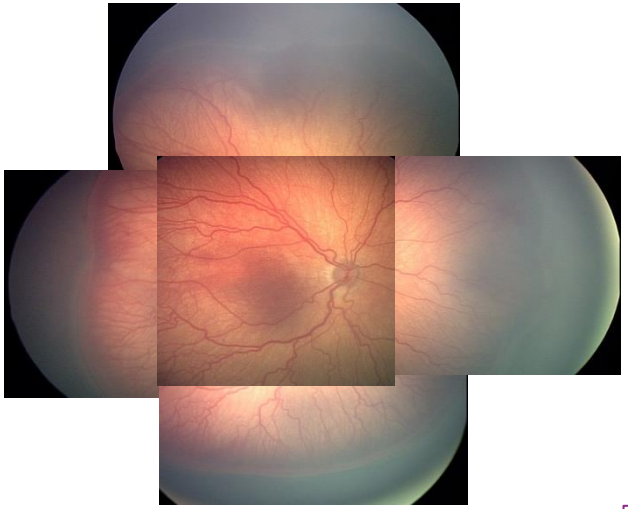
- Abnormal proliferation of blood vessels
- Scarring or retinal detachment
- Blindness





Affects approximately **34%** **of premature newborns**

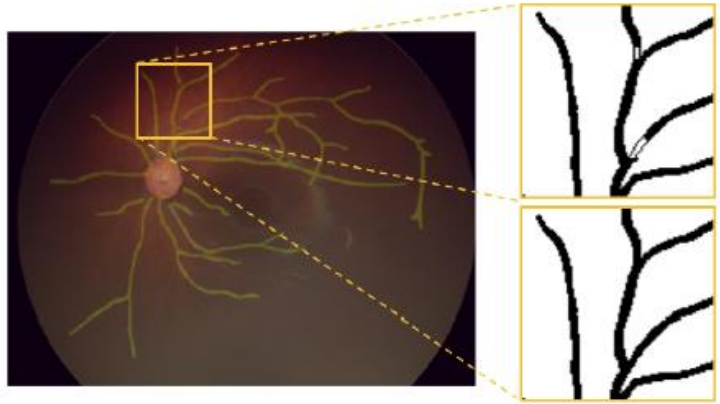
ROP: Solution



ROP Database

ROPKID

Software AI

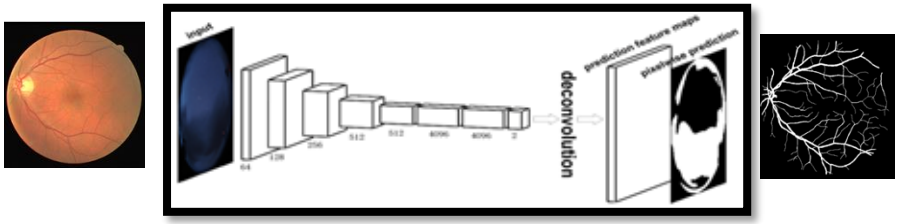


AI-assisted diagnostic system that improves ROP detection.

Structured report with **classification** and **probability**.

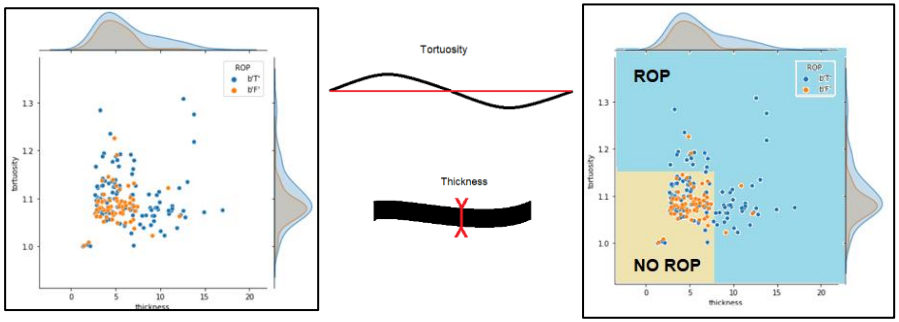
ROP

Phase 1: Segmentation and feature extraction through AI-based image processing.



Evaluator	*Score*
AUC ROC curve	0.98
F-measure score (F1)	0.83
Accuracy	0.96
Sensitivity	0.79
Specificity	0.98
Precision	0.88

Phase 2: Classification (Plus/Non-plus, ROP/No-ROP).



Classification Accuracy of Plus / Non-Plus: 0.71

SJD Sant Joan de Déu Barcelona · Hospital



Christian Mata Miquel
christian.mata@upc.edu

Thank you