A ABBREVIATIONS

EF	Ejection Fraction
IVSd	Interventricular Septal Thickness in Diastole
LVIDd	Left Ventricular Internal Diameter in Diastole
LVPWd	Left Ventricular Posterior Wall Thickness in Diastole
A2C, A3C, A4C	Apical 2-, 3-, and 4-Chamber Views
PLAX	Parasternal Long-Axis View
PSAX	Parasternal Short-Axis View
STEMI	ST-Elevation Myocardial Infarction
AS	Aortic Stenosis
PAH	Pulmonary Arterial Hypertension
ASD	Atrial Septal Defect
RWMA	Regional Wall Motion Abnormality
MAE	Mean Absolute Error
MSE	Mean Squared Error
RMSE	Root Mean Squared Error
ARI	Adjusted Rand Index
kNN	k-Nearest Neighbors
FM	Foundation Model
Δ	Difference between max and min subgroup performance

B MODELS

Table 4 provides a high-level comparison, while below each model is described in more detail. CardioBench compares echocardiography-specific, biomedical, and general-purpose foundation models. **EchoCLIP** Christensen et al. (2023) adapts a ConvNeXt-B vision encoder with a CLIP-style text tower, trained contrastively on 1M A4C echo videos and reports, aligning video embeddings with task-specific prompts at inference. **EchoPrime** Vukadinovic et al. (2024) combines a multi-view ViT (mViT) with BioMedBERT and uses retrieval, projecting test videos into a joint embedding space and predicting by matching to labeled exemplars. **PanEcho** Holste et al. (2025) employs a ConvNeXt-T backbone with a temporal frame transformer, trained on 1.2M multiview echo videos for multitask regression and classification. **EchoFM** Kim et al. (2024) uses a ViT-L/16 video encoder trained on 290K multiview echo videos to learn general embeddings optimized for probing. As the linear heads are not provided, and the model doesn't have the text encoder, zero-shot cannot be performed **BioMedCLIP** Zhang et al. (2023) pairs a ViT-B/16 with PubMedBERT, pretrained on 15M biomedical image–text pairs spanning radiology, pathology, microscopy, and ultrasound. **DINOv3** Siméoni et al. (2025) is a self-supervised ViT-L/16 trained on 1.7B natural images with an aligned text encoder, applied by encoding frames and pooling temporally before probing or computing similarity with handcrafted prompts. Finally, **SigLIP2** Tschannen et al. (2025) is a multilingual vision–language model with a ViT-B/16 backbone and transformer text tower, trained on 10B WebLI pairs. Together, these models allow us to assess how far both biomedical and large-scale generic supervision can be transferred to echocardiography tasks, and whether modality-specific pretraining is necessary to achieve competitive performance.

Table 4: Summary of evaluated foundation models with vision/text encoders, temporal design, and dataset scale.

Model	Vision encoder	Text encoder	Temporal modeling	Training data
EchoCLIP	ConvNeXt-B	CLIPTextModel	–	1.03M A4C echo videos + reports
EchoPrime	mViT	BioMedBERT	Video encoder	12.1M multiview echo videos + reports
PanEcho	ConvNeXt-T	–	Frame Transformer	1.2M multiview echo videos
EchoFM	ViT-L/16	–	Video encoder	290K multiview echo videos
BioMedCLIP	ViT-B/16	PubMedBERT	–	15M image–caption pairs
DINOv3	ViT-L/16	–	–	1.7B natural images
SigLIP2	ViT-B/16	ViT-style tower	–	10B WebLI images

Table 5: Echocardiography datasets used in this study, with their source, accessibility, and modality.

Dataset	Source	Availability	Data type
EchoNet-Dynamic Ouyang et al. (2020)	Stanford AIMI	Open download	Video
EchoNet-Pediatric Reddy et al. (2023)	Stanford AIMI	Open download	Video
EchoNet-LVH Duffy et al. (2022)	Stanford AIMI	Open download	Video
SegRWMA Liu et al. (2023)	Kaggle	Open download	Video
CardiacNet Yang et al. (2024)	Kaggle	Open download	Video
CAMUS Leclerc et al. (2019)	Université de Lyon	Open download	Video
HMC-QU Degerli et al. (2021)	Private	Upon request	Video
TMED-2 Huang et al. (2022)	Private	Upon request	Image

Table 6: Summary of dataset characteristics, including sizes, splits, and available labels. Datasets for which we adopt the official split are indicated with ●, for other datasets we define a custom split.

Dataset	Size	Train/Val/Test	Labels Used	View
EchoNet-Dynamic ●	10,030 videos	7,465/1,288/1,277	EF	A4C
EchoNet-Pediatric ●	7,810 videos	6,365/798/658	Age, Sex, Weight, Height	A4C
EchoNet-LVH ●	12,000 videos	10,490/1,167/343	IVSd, LVIDd, LVPWd	PLAX
SegRWMA	529 videos	221/152/156	RWMA	A4C, A3C, A2C
CardiacNet-ASD	228 videos	158/23/47	ASD	A4C
CardiacNet-PAH	471 videos	319/51/106	PAH	A4C
CAMUS ●	1,000 videos	400/50/50	EF, Sex, Age, Image Quality	A4C, A2C
HMC-QU	322 videos	227/45/50	STEMI	A4C, A2C
TMED-2 ●	17,270 images	360/119/119	AS	A4C, A2C, PSAX, PLAX

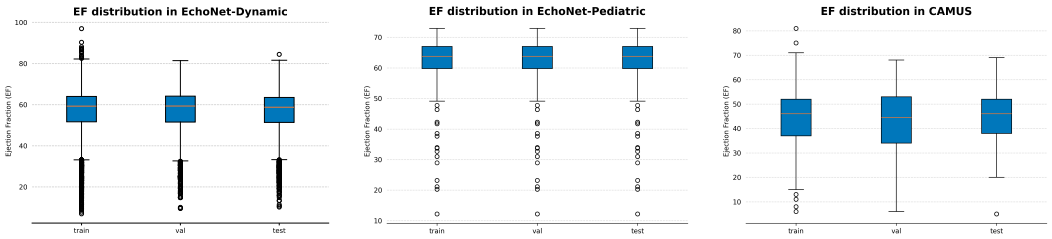
C DATASETS

In this section, we motivate the choice of datasets for evaluation, provide the distribution of values in each dataset, and describe the splitting strategy.

C.1 DATASET SELECTION

Because echocardiography involves sensitive patient information, the number and size of public datasets are limited. We use eight datasets that are either openly downloadable or available upon request. Table 5 summarizes their key characteristics.

Table 6 provides an overview of dataset sizes, experimental splits, and available labels. For the CAMUS and TMED-2 datasets, we report the total number of unique videos and images, with splits defined at the patient level. For the other datasets, we assume one video per patient. We also indicate the type of annotations provided and describe how the data were partitioned into training, validation, and testing sets. Where applicable, we additionally summarize the distribution of classes.



(a) EchoNet-Dynamic EF (b) EchoNet-Pediatric EF (c) CAMUS EF

Figure 6: Box plots of EF distributions across three datasets: EchoNet-Dynamic, EchoNet-Pediatric, and CAMUS.

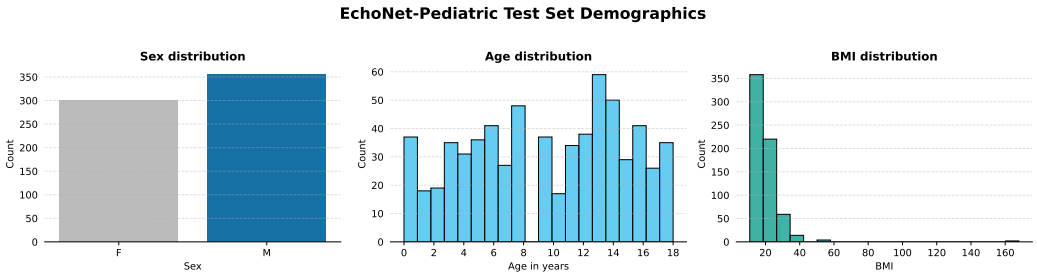


Figure 7: Distribution of sex, age, and BMI for video samples in the EchoNet-Pediatric dataset.

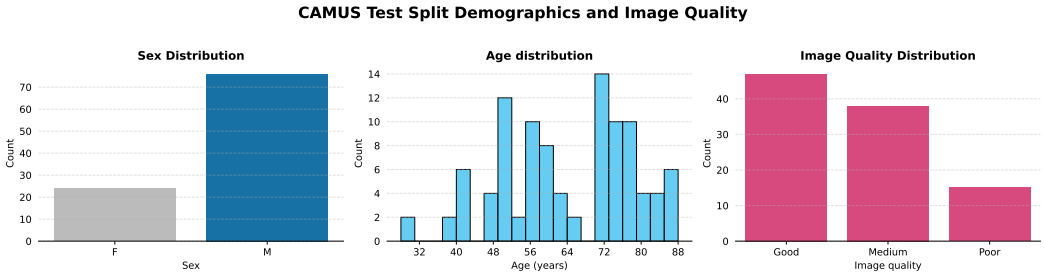


Figure 8: Distribution of sex, age, and image quality in the CAMUS dataset.

C.2 Dataset Details

EchoNet-Dynamic. The dataset consists of 10,030 A4C echocardiography videos, each from a unique patient. Every video is annotated with an EF value, with the distribution shown in Figure 6a.

EchoNet-Pediatric. The dataset comprises 7,810 videos, including 4,526 PSAX and 3,284 A4C echocardiography recordings, with one video per patient. Each video is annotated with EF, sex, age, weight, and height, from which body mass index (BMI) is derived. The EF distribution is shown in Figure 6b, and the demographic distributions are presented in Figure 7.

EchoNet-LVH. The EchoNet-LVH dataset contains 12,000 PLAX-view videos, each annotated with the frame on which structural measurements (IVSd, LVIDd, LVPWd) are performed, with their distributions shown in Figure 9.

CAMUS. The CAMUS dataset comprises 500 patients, each with two echocardiography views (A2C and A4C). Each video is annotated with sex, age, EF, and image quality. We follow the official split of 400 patients for training, 50 for validation, and 50 for testing. The EF distribution is shown in Figure 6c, and the demographic distributions are presented in Figure 8.

SegRWMA. The SegRWMA dataset includes 198 patients with regional wall motion annotations, comprising 14 abnormal cases in the A4C view, 13 in the A3C view, and 12 in the A2C view, with the remaining patients considered normal. Segmentation masks are provided for the annotated frames, and we use the first annotated frame index for evaluation. In this study, we restrict analysis to the 2D ultrasound modality, as it is more cost-effective than contrast-enhanced echocardiography Liu et al. (2023). To prevent data leakage, the dataset is split at the patient level, ensuring that no patient appears in multiple splits. As shown in Figure 10, the abnormality distribution is imbalanced across splits: in the A2C view, 4 abnormal patients are in training, 5 in testing, and 3 in validation; in the A3C view, 6 are in training, 4 in testing, and 3 in validation; and in the A4C view, 6 are in training, 4 in testing, and 4 in validation. The remaining patients in each split are normal.

CardiacNet. The CardiacNet dataset contains 228 videos for ASD and 529 videos for PAH. Following the authors Yang et al. (2024), we treat each video as a separate patient. The dataset is

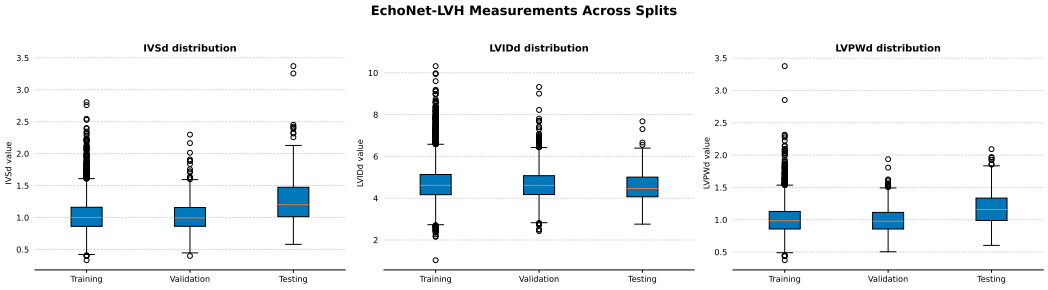


Figure 9: Distribution of structural measurements in the EchoNet-LVH dataset.

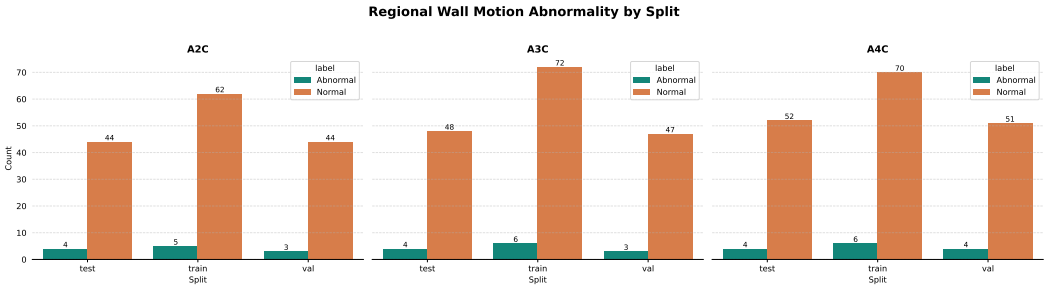


Figure 10: Distribution of regional wall motion abnormalities in the SegRWMA dataset across A2C, A3C, and A4C views and dataset splits.

divided independently for each task according to its distribution. For the CardiacNet-ASD subset, we apply a stratified split to preserve the proportion of ASD and non-ASD cases across subsets: 20% of patients are held out for testing, while the remaining 80% are further split, with 12.5% allocated to validation. For the CardiacNet-PAH subset, we use patient-level labels and again perform a stratified split to preserve the proportion of PAH and non-PAH cases: 20% of patients are reserved for testing, and from the remaining 80%, 12.5% are allocated to validation. The distribution of binary labels across splits for both ASD and PAH tasks is shown in Figure 11.

HMC-QU. The HMC-QU dataset contains 332 videos of A4C and A2C views with STEMI labels. Using patient-level labels, we apply a stratified split to maintain the STEMI/non-STEMI ratio across subsets. The dataset is divided into approximately 70.8% for training, 14.2% for validation, and 15% for testing, ensuring that all videos from the same patient remain in a single subset. We treat each video as a separate test case due to the relatively small dataset size. The distribution of STEMI and non-STEMI cases across splits is shown in Figure 12a.

TMED-2. TMED-2 is the only image dataset in our study, comprising 17,270 images across views: 1,670 A2C, 2,206 A4C, 4,808 PLAX, 1,725 PSAX, and 6,861 labeled as Other (A2C, A4C, or other views). Since many images belong to the same study, they are grouped into 598 studies in total. Following the official DEV479 split, the dataset is partitioned into 360 studies for training, 119 for validation, and 119 for testing. We also binarize the labels from multiclass classification into aortic stenosis "present" and "absent." The distribution of binary aortic stenosis labels across splits is presented in Figure 12b.

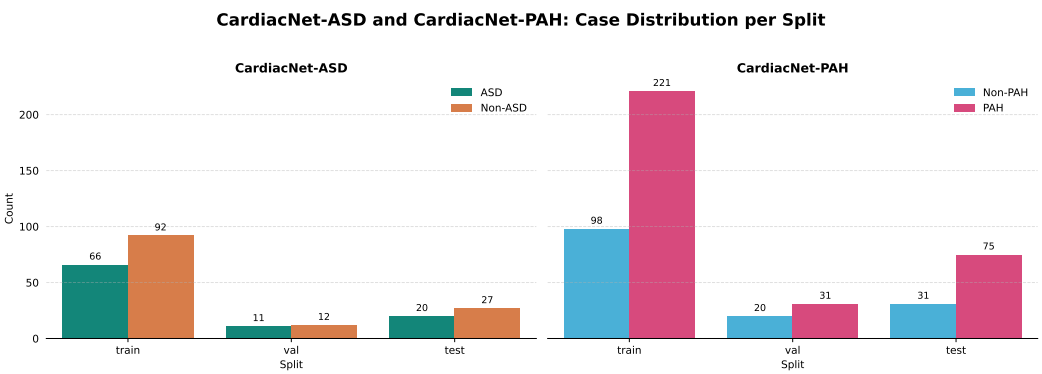
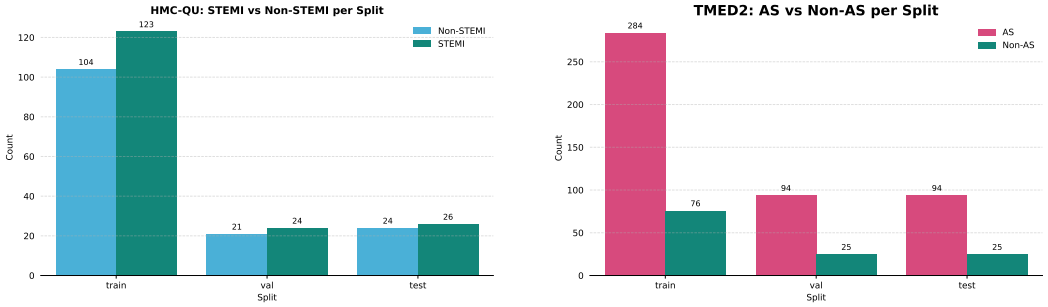


Figure 11: Distribution of binary labels in the CardiacNet dataset for ASD and PAH across training, validation, and test splits.



(a) Distribution of STEMI and non-STEMI cases in the HMC-QU dataset across training, validation, and test splits.

(b) Distribution of aortic stenosis cases (present vs. absent) in the TMED-2 dataset across training, validation, and test splits.

Figure 12: Overview of label distributions across splits for the HMC-QU and TMED-2 datasets.

D REPRODUCIBILITY

Each ultrasound video $V \in \Re^{T\times H\times W}$ is represented by 16 consecutive frames, normalized and resized to 224×224, yielding $X \in \Re^{16\times 224\times 224}$. A video encoder f_θ produces an embedding $z_v = f_\theta(X) \in \Re^d$, while a text prompt P is mapped by a text encoder g_θ into $z_p = g_\theta(P) \in \Re^d$. For models originally designed for single images, we extend them to videos by computing predictions frame-wise and reporting the mean of the outputs across the 16 frames.

Zero-shot evaluation. For classification, we define one prompt per class $(P_1, \ldots, P_k)$ and predict using cosine similarity: $\hat{y} = \arg\max_c \cos(z_v, z_{p_c})$. This $\arg\max$ rule avoids dataset-specific thresholds, ensuring a calibration-free and reproducible evaluation. For regression tasks, we follow Christensen et al. (2023) by constructing prompts with numerical values over a predefined range. Predictions are obtained by aggregating frame-wise similarities (median of the top 20% per frame, averaged across frames). Prompt templates and robustness checks are detailed in Appendix E.

Probing. We assess the quality of the learned representations applying two lightweight classifiers directly on the embedding space. First, we perform linear probing by freezing the model's parameters and training a linear classifier on top of the embeddings. Linear probing tests whether the information needed for a task is linearly accessible. Second, for view classification task, we apply k-nearest neighbor (kNN) classification directly in the embedding space. Unlike linear probing, kNN evaluates whether local structure in the embedding space naturally reflects clinically meaningful view categories. By combining linear probing for global linear separability with kNN for local structure, we obtain complementary insights into how foundation models encode clinical information.

Training is carried out using the AdamW optimizer on the linear head only using a learning rate of 1e-4 with a weight decay of 1e-2. We use a batch size of 64, applying cross-entropy loss for classification tasks and mean squared error (MSE) loss for regression tasks. Early stopping is applied on the validation split to prevent overfitting. All experiments are conducted on an NVIDIA RTX A6000 GPU.

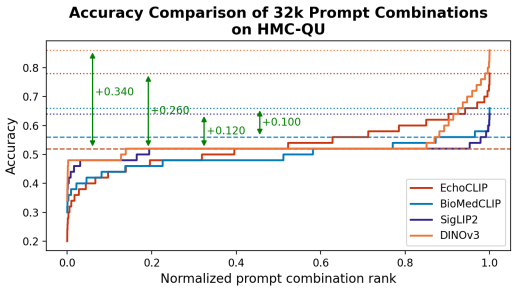


Figure 13: Accuracy over 32k prompt combinations on HMC-QU STEMI classification. Solid curves show accuracy trends, dotted lines indicate peak accuracies, and dashed lines mark baseline accuracies.

E PROMPTS

The prompt design follows the standard established by Christensen et al. (2023). Their exact ejection fraction prompt is used directly, while the prompts for the remaining tasks are generated in accordance with the same style. To improve robustness and reduce prompt-specific bias, we instantiate multiple phrasings per class (classification) or per numeric value (regression). For classification, the mean similarity is computed separately for each class and the class with the higher mean is selected. For regression, numerical placeholders are replaced with candidate values from a predefined grid, and the value corresponding to the prompt with the highest similarity is selected as the prediction. Specifically, ejection fraction is instantiated over integer values from 0–100%, while chamber dimensions and wall thicknesses are instantiated over clinically reasonable ranges with 0.1 cm resolution: LVIDd from 2.0–8.0 cm, IVSd from 0.5–2.0 cm, and LVPWd from 0.5–2.0 cm. All prompts and instantiation ranges are released on GitHub to ensure reproducibility.

To examine the effect of prompt design on model performance, we experimented with 32k different prompt combinations on the HMC-QU classification dataset. Our generated prompts are fixed as the baseline, and we additionally create variants with both relevant and irrelevant details. Figure 13 illustrates the gain in accuracy achieved by alternative combinations. Accuracy remains largely unchanged across most combinations, though a subset yields noticeable improvements. Importantly, the models do not reach their highest accuracy on the same prompt combination. Therefore, we retain our original prompts as the baseline choice.

Example of a regression-based prompt where the numerical variable is changed to a number with a predefined range.

```
"ejection_fraction":
  "THE LEFT VENTRICULAR EJECTION FRACTION IS ESTIMATED TO BE <#>%",
  "LV EJECTION FRACTION IS <#>%."
"LVIDd":
  "LEFT VENTRICULAR INTERNAL DIAMETER IN DIASTOLE (LVIDD) IS <#> CM.",
  "LVIDD IS <#> CM.",
```

Example of classification prompts

```
"Aortic Stenosis positive class":
  "AORTIC STENOSIS IS PRESENT. ",
  "SEVERE AORTIC STENOSIS. ",
  "CALCIFIED AORTIC VALVE WITH RESTRICTED LEAFLET MOTION. ",
"Aortic Stenosis negative class":
  "NO AORTIC STENOSIS. ",
  "NO SIGNIFICANT AORTIC VALVE STENOSIS. ",
  "AORTIC VALVE OPENS NORMALLY WITHOUT STENOSIS. ",
```

F ADDITIONAL EVALUATION

Representation alignment across models. We study how encoders structure echocardiogram videos by comparing their embedding spaces with Canonical Correlation Analysis (CCA) and Centered Kernel Alignment (CKA). CCA provides low-dimensional projections for qualitative comparison, while CKA yields a scale- and rotation-invariant similarity score in $[0, 1]$. Figure 14 shows the two most correlated CCA dimensions when aligning DINOv3 to other models on CAMUS. The top row visualizes the distribution of DINOv3 embeddings colored by ejection-fraction (EF) bins; the bottom row shows the corresponding aligned coordinates for SigLIP2, BioMedCLIP, EchoCLIP, EchoPrime, and PanEcho, alongside their CKA similarity to DINOv3. Models with higher CKA tend to preserve DINOv3's large-scale geometry in the aligned space, suggesting more compatible feature organization.

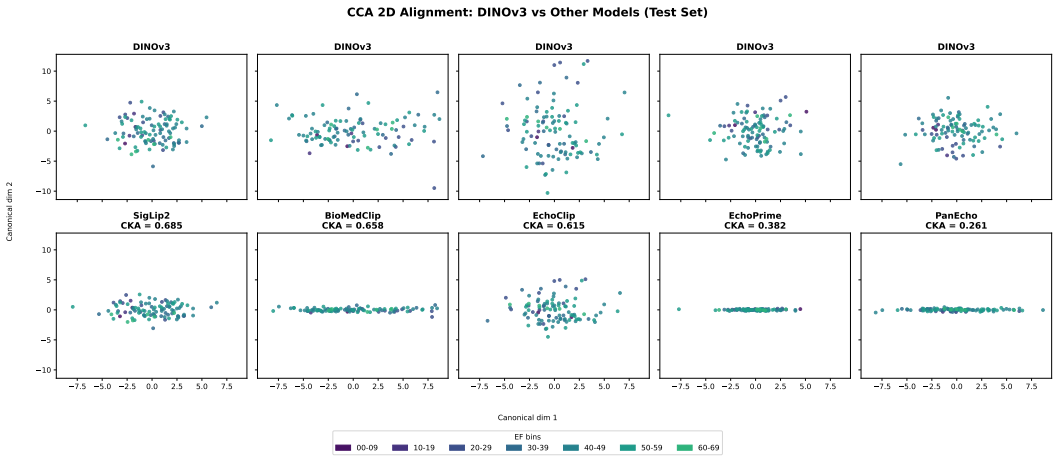
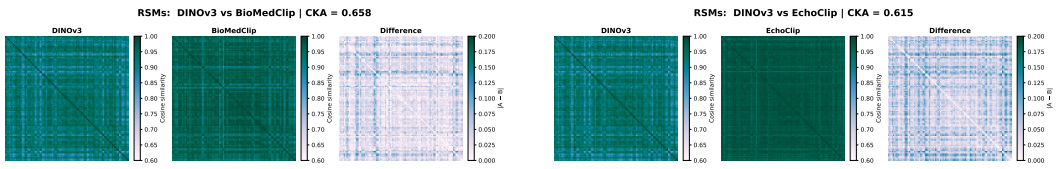


Figure 14: CCA 2D alignment between DINOv3 and other models on the CAMUS test set. Top row shows the distribution of DINOv3 embeddings across canonical dimensions, colored by EF bins. Bottom row shows aligned embeddings for SigLIP2, BioMedCLIP, EchoCLIP, EchoPrime, and PanEcho, with corresponding CKA similarity values to DINOv3.

Relational structure via RSMs. To examine patient-level relationships, we compute Representation Similarity Matrices (RSMs) that capture pairwise cosine similarities within each model (Fig. 15). Difference maps against DINOv3 highlight where models agree (lighter) or diverge (darker) in inter-patient structure. On CAMUS, BioMedCLIP's RSM is more consistent with DINOv3 than EchoCLIP's, indicating closer relational alignment among generic vision-language and vision-only encoders than with echo-specialized ones.



(a) RSMs of DINOv3 and BioMedCLIP

(b) RSMs of DINOv3 and EchoCLIP

Figure 15: RSMs for DINOv3 and other models on the CAMUS test set. Matrices show pairwise cosine similarity between patient embeddings, while difference plots highlight agreement (light) or divergence (dark) in inter-patient relationships relative to DINOv3.

Cross-dataset agreement. At the dataset level, correlations between model-wise embedding statistics are generally weak (Fig. 16, left). A PCA of the inter-model correlation matrix (Fig. 16, right) shows models scatter rather than forming a tight cluster, with only a mild tendency for general-purpose encoders to lie closer together. Overall, the models impose distinct relational geometries

on the same data, underscoring that comparable downstream scores can arise from meaningfully different internal organizations.

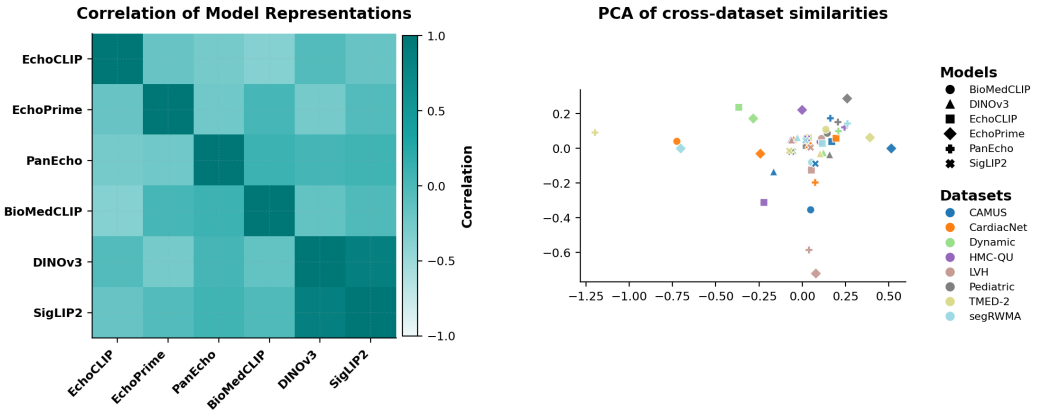


Figure 16: Correlation matrices of model embeddings (left) quantify how similarly models structure echocardiogram datasets, while PCA projections of these correlations (right) provide a 2D visualization that reveals groupings among general-purpose and echo-specific encoders

Clustering consistency. We further assess how well embeddings recover clinically meaningful view categories (A2C, A4C, PLAX, PSAX, Other) using the Adjusted Rand Index (ARI), which corrects for chance. Higher ARI indicates that a model's local neighborhoods align with true view labels, complementing CKA (global structure) and RSMs (pairwise relations) by probing cluster fidelity in the latent space (examples in Figs. 17 and 18).

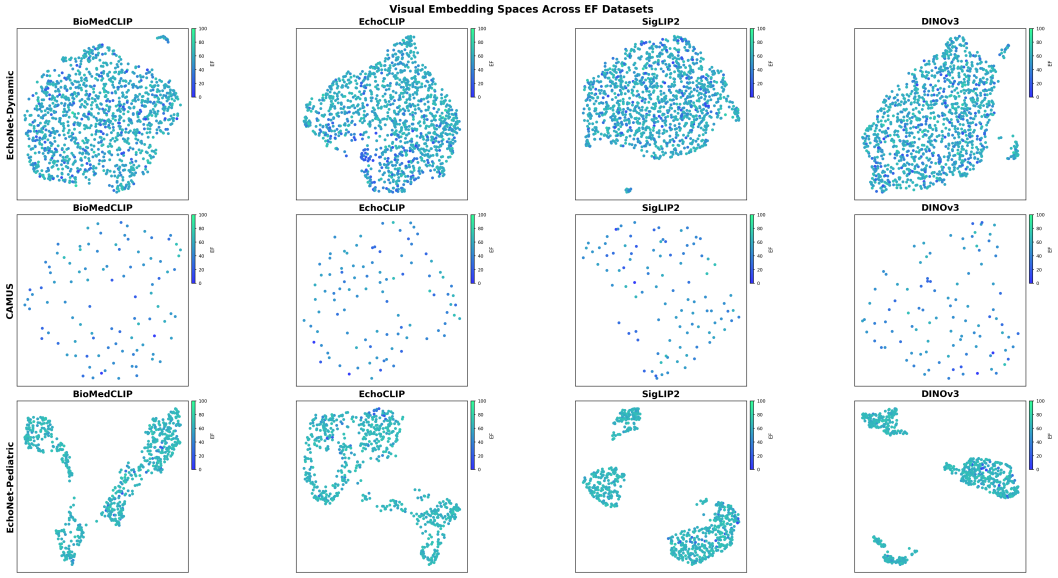


Figure 17: UMAP of visual representations on EchoNet-Dynamic, CAMUS, EchoNet-Pediatric Datasets

Prompt–embedding alignment. We visualize how visual and text embeddings interact across three clinical tasks (ASD, PAH, and STEMI) in Figs. 19–21. For each dataset, the top row shows 2D projections of visual embeddings colored by disease status, the middle row shows the corresponding positive and negative text prompt embeddings, and the bottom row depicts projection margins indicating alignment with the "Present" prompt. These visualizations highlight how well

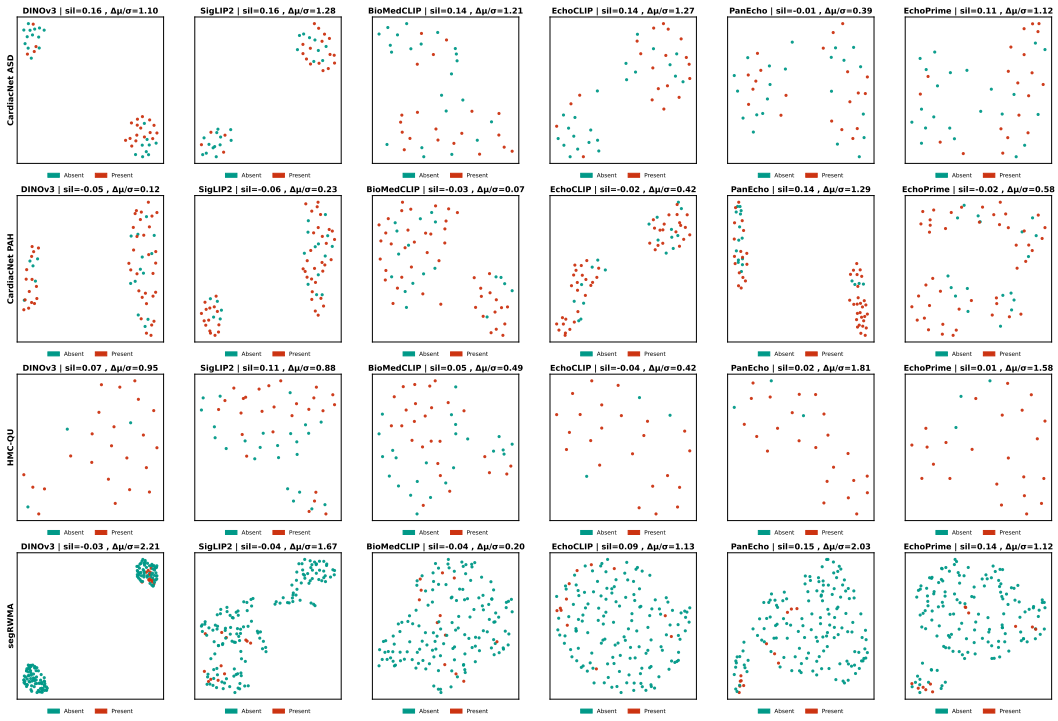


Figure 18: UMAP of visual representations on CardiacNet, HMC-QU, and segRWMA datasets.

foundation models separate disease classes in the latent space and reveal the degree to which visual embeddings align with textual supervision, offering qualitative insight that complements quantitative performance metrics. In the case of ASD (Fig. 19), DINOv3 achieves a clean separation of absent and present cases in the visual space, while SigLIP2 and BioMedCLIP show partial overlap between classes. However, the projection plots reveal that DINOv3 margins remain consistently negative with limited class separation, SigLIP2 exhibits small but coherent margins, BioMedCLIP shows weak alignment centered near zero, and EchoCLIP margins are widely dispersed across both groups.

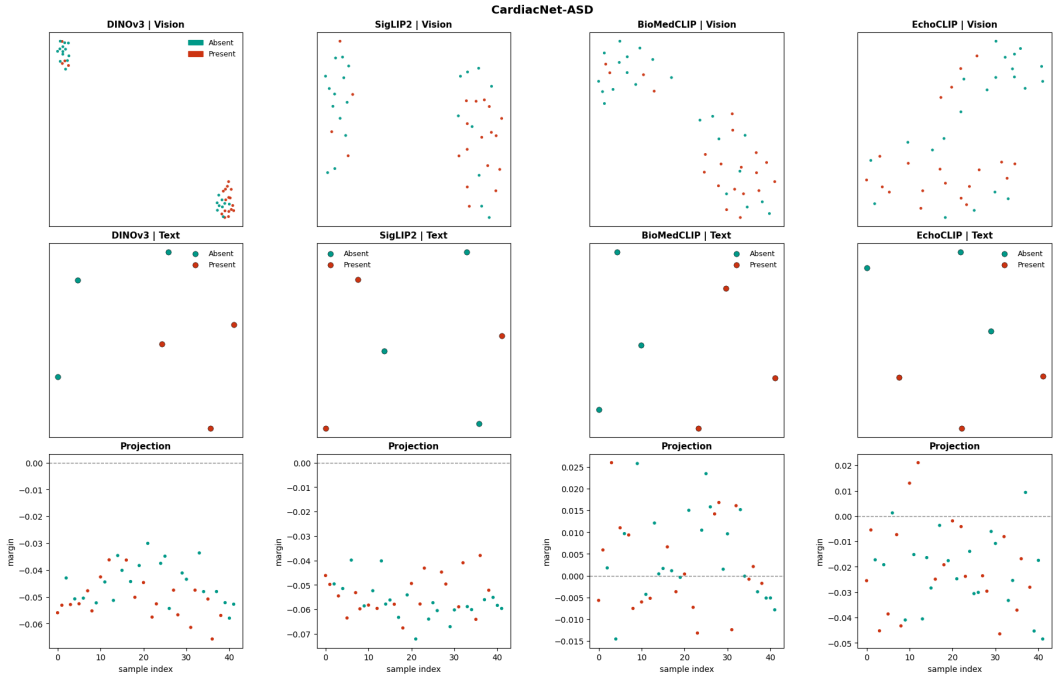


Figure 19: Embedding visualizations on the CardiacNet-ASD test set. Top: visual embeddings colored by ASD status. Middle: text prompt embeddings. Bottom: projection margins showing alignment with the "Present" prompt.

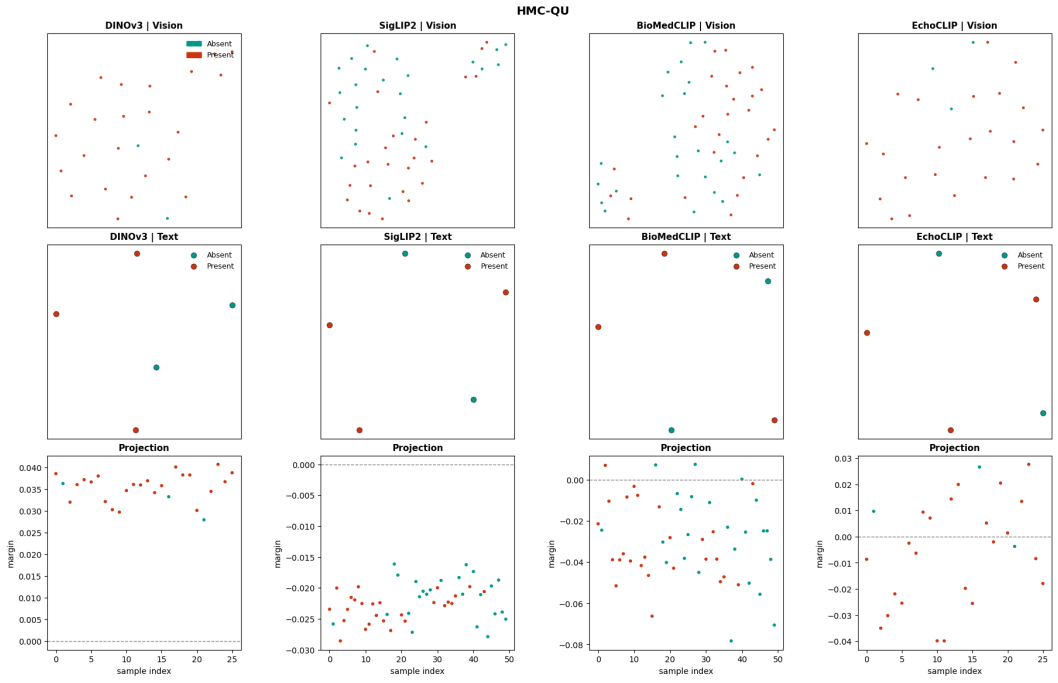


Figure 21: Embedding visualizations on the HMC-QU test set. Top: visual embeddings colored by STEMI status. Middle: text prompt embeddings. Bottom: projection margins showing alignment with the "Present" prompt.

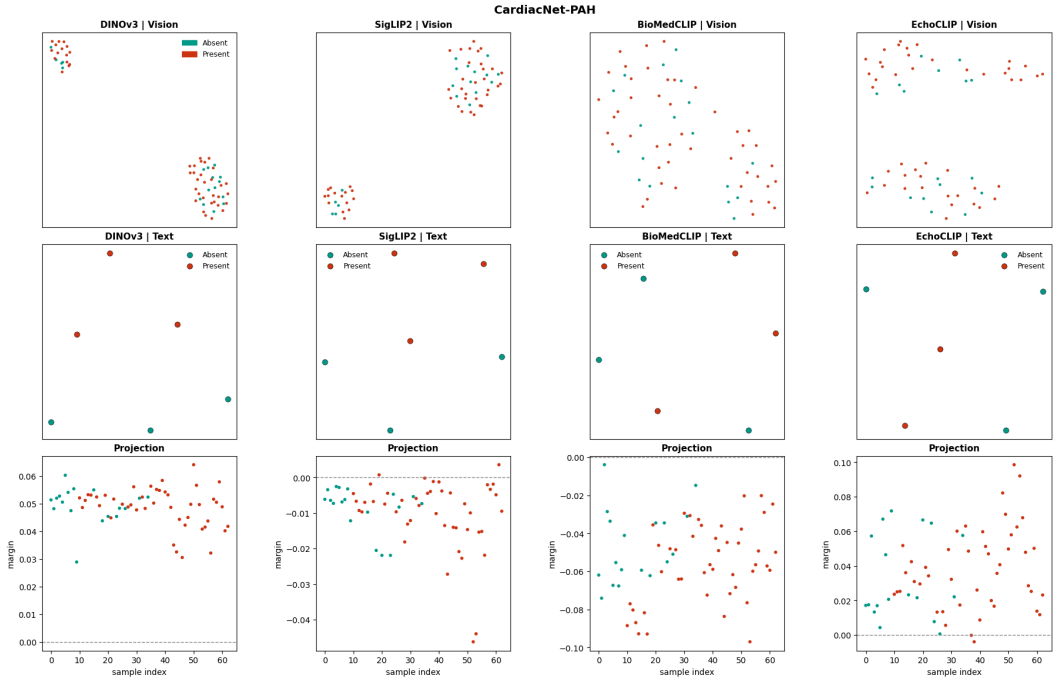


Figure 20: Embedding visualizations on the CardiacNet-PAH test set. Top: visual embeddings colored by PAH status. Middle: text prompt embeddings. Bottom: projection margins showing alignment with the "Present" prompt.

G Full Results

Table 8: Zero-shot and linear probing performance on structural targets in EchoNet-LVH with 95% confidence intervals.

				MAE			NMAE (%)			RMSE			R^2 (%)		
Dataset	**Model**	**Target**	n	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**
Zero	EchoCLIP	IVSd	339	0.57	0.58	[0.54–0.61]	20.60	22.38	[19.62–32.02]	0.67	0.67	[0.63–0.72]	-203.06	-207.37	[-262.66—157.47]
	PanEcho	IVSd	339	0.21	0.21	[0.19–0.23]	7.45	8.10	[6.86–11.63]	0.30	0.30	[0.26–0.34]	39.67	39.27	[32.14–46.50]
	BioMedCLIP	IVSd	339	0.28	0.28	[0.25–0.32]	10.18	11.07	[9.45–15.81]	0.41	0.41	[0.36–0.47]	-13.80	-14.34	[-23.33—6.07]
	DINOv3	IVSd	339	0.28	0.28	[0.26–0.31]	10.16	11.02	[9.52–15.54]	0.39	0.39	[0.34–0.44]	-0.36	-0.66	[-2.54–0.00]
	SigLIP2	IVSd	339	0.28	0.28	[0.26–0.31]	10.15	11.01	[9.50–15.52]	0.39	0.39	[0.34–0.44]	-0.42	-0.71	[-2.67–0.00]
	EchoCLIP	LVIDd	340	0.79	0.79	[0.73–0.85]	16.12	17.28	[15.19–21.61]	0.97	0.97	[0.90–1.03]	-87.10	-89.38	[-125.56—60.11]
	PanEcho	LVIDd	340	0.36	0.36	[0.33–0.39]	7.28	7.80	[6.87–9.68]	0.45	0.45	[0.41–0.49]	59.90	59.55	[52.02–66.04]
	BioMedCLIP	LVIDd	340	0.97	0.97	[0.90–1.03]	19.67	21.09	[18.68–26.80]	1.14	1.14	[1.07–1.21]	-160.88	-164.43	[-221.77—117.61]
	DINOv3	LVIDd	340	0.69	0.69	[0.64–0.74]	13.98	14.99	[13.26–18.76]	0.84	0.83	[0.78–0.89]	-39.08	-40.39	[-60.89—25.07]
	SigLIP2	LVIDd	340	0.69	0.69	[0.64–0.74]	13.99	15.00	[13.27–18.78]	0.84	0.83	[0.78–0.89]	-39.23	-40.54	[-61.09—25.17]
	EchoCLIP	LVPWd	340	0.41	0.41	[0.38–0.44]	27.63	29.08	[25.96–32.93]	0.50	0.50	[0.47–0.53]	-249.10	-251.58	[-300.51—211.68]
	PanEcho	LVPWd	340	0.18	0.18	[0.17–0.19]	12.04	12.68	[11.35–14.34]	0.23	0.23	[0.21–0.24]	28.59	28.13	[16.79–37.97]
	BioMedCLIP	LVPWd	340	0.26	0.26	[0.24–0.28]	17.59	18.49	[16.57–20.86]	0.32	0.32	[0.30–0.34]	-42.39	-43.16	[-62.80—28.40]
	DINOv3	LVPWd	340	0.22	0.22	[0.21–0.24]	15.02	15.79	[14.13–17.81]	0.28	0.28	[0.26–0.30]	-6.73	-7.11	[-15.05—2.24]
	SigLIP2	LVPWd	340	0.22	0.22	[0.21–0.24]	15.03	15.80	[14.14–17.82]	0.28	0.28	[0.26–0.30]	-6.83	-7.23	[-15.22—2.30]
Linear Probing	EchoCLIP	IVSd	339	0.28	0.29	[0.25–0.32]	10.20	11.10	[9.36–15.83]	0.42	0.42	[0.37–0.48]	-20.16	-21.03	[-32.48—11.33]
	EchoPrime	IVSd	339	0.25	0.25	[0.22–0.28]	9.00	9.79	[8.24–13.90]	0.38	0.38	[0.33–0.43]	3.55	3.05	[-6.04–11.64]
	PanEcho	IVSd	339	0.18	0.18	[0.16–0.20]	6.47	7.03	[6.00–9.98]	0.27	0.26	[0.23–0.31]	52.76	52.51	[46.54–58.44]
	BioMedCLIP	IVSd	339	0.30	0.30	[0.27–0.33]	10.61	11.54	[9.83–16.49]	0.42	0.42	[0.37–0.47]	-18.36	-19.19	[-30.36—9.25]
	DINOv3	IVSd	339	0.27	0.28	[0.25–0.31]	9.84	10.71	[9.04–15.30]	0.40	0.40	[0.35–0.46]	-8.93	-9.79	[-19.98—0.94]
	SigLIP2	IVSd	339	0.30	0.30	[0.27–0.34]	10.86	11.82	[10.02–16.83]	0.44	0.44	[0.38–0.49]	-28.17	-29.15	[-41.49—18.49]
	EchoFM	IVSd	339	0.32	0.32	[0.29–0.36]	11.59	12.63	[10.75–17.93]	0.46	0.46	[0.40–0.52]	-41.10	-42.28	[-55.21—31.12]
	EchoCLIP	LVIDd	340	0.47	0.47	[0.43–0.51]	9.55	10.23	[8.93–12.71]	0.60	0.59	[0.54–0.65]	29.30	28.72	[16.40–39.24]
	EchoPrime	LVIDd	340	0.41	0.41	[0.37–0.44]	8.30	8.90	[7.70–11.06]	0.54	0.54	[0.48–0.59]	42.44	41.83	[28.67–53.52]
	PanEcho	LVIDd	340	0.35	0.35	[0.32–0.38]	7.16	7.67	[6.64–9.64]	0.45	0.45	[0.41–0.49]	58.87	58.41	[48.50–67.55]
	BioMedCLIP	LVIDd	340	0.52	0.52	[0.47–0.56]	10.51	11.26	[9.89–14.01]	0.65	0.65	[0.60–0.71]	15.14	14.51	[5.72–21.56]
	DINOv3	LVIDd	340	0.47	0.47	[0.43–0.51]	9.55	10.22	[8.96–12.54]	0.60	0.60	[0.55–0.66]	28.14	27.82	[19.30–35.79]
	SigLIP2	LVIDd	340	0.51	0.51	[0.47–0.56]	10.38	11.12	[9.75–13.74]	0.65	0.65	[0.59–0.71]	15.34	14.86	[5.85–22.72]
	EchoFM	LVIDd	340	0.57	0.57	[0.52–0.62]	11.59	12.41	[10.97–15.37]	0.71	0.71	[0.66–0.78]	-1.85	-2.37	[-8.57–2.29]
	EchoCLIP	LVPWd	340	0.22	0.22	[0.20–0.24]	14.59	15.36	[13.53–17.63]	0.29	0.29	[0.26–0.32]	-17.64	-18.24	[-30.21—6.74]
	EchoPrime	LVPWd	340	0.19	0.19	[0.17–0.21]	12.73	13.41	[11.91–15.31]	0.25	0.25	[0.23–0.28]	9.10	8.65	[-2.06–18.58]
	PanEcho	LVPWd	340	0.15	0.15	[0.14–0.16]	9.96	10.48	[9.41–11.87]	0.19	0.19	[0.17–0.21]	48.89	48.58	[40.67–55.93]
	BioMedCLIP	LVPWd	340	0.23	0.23	[0.21–0.25]	15.18	15.98	[14.11–18.17]	0.30	0.30	[0.27–0.33]	-25.09	-25.68	[-38.30—14.00]
	DINOv3	LVPWd	340	0.21	0.21	[0.19–0.23]	14.11	14.86	[13.21–16.93]	0.28	0.28	[0.25–0.30]	-8.57	-9.11	[-20.28–1.02]
	SigLIP2	LVPWd	340	0.23	0.23	[0.21–0.25]	15.15	15.95	[14.08–18.20]	0.30	0.30	[0.27–0.33]	-27.05	-27.68	[-40.50—16.37]
	EchoFM	LVPWd	340	0.24	0.24	[0.22–0.27]	16.30	17.16	[15.19–19.56]	0.32	0.32	[0.29–0.35]	-43.83	-44.57	[-58.40—30.70]

Table 7: EF zero-shot results on EchoNet-Dynamic, CAMUS, and EchoNet-Pediatric with 95% confidence intervals. The *View* column indicates the view of the ground truth: EchoNet-Dynamic corresponds to A4C; CAMUS includes both A2C and A4C. In the main paper, results are reported at the study level, but here we additionally provide view-specific results. For EchoNet-Pediatric, we report results for each individual view as well as for the combined set of views.

				MAE			NMAE (%)			RMSE			R^2 (%)		
Dataset	**Model**	**View**	n	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**
EchoNet-Dynamic	EchoCLIP	A4C	1277	9.99	9.98	[9.53–10.42]	13.45	13.79	[12.96–15.01]	12.99	12.98	[12.38–13.55]	-12.94	-12.91	[-25.60—0.89]
	EchoPrime	A4C	1277	7.78	7.79	[7.35–8.20]	10.48	10.76	[10.04–11.79]	10.87	10.87	[10.29–11.42]	21.00	20.93	[16.17–25.40]
	PanEcho	A4C	1277	5.79	5.79	[5.50–6.10]	7.79	8.00	[7.45–8.76]	8.11	8.11	[7.65–8.59]	56.00	55.93	[50.11–61.27]
	BioMedCLIP	A4C	1277	13.83	13.83	[13.45–14.25]	18.63	19.11	[18.26–20.85]	15.62	15.62	[15.22–16.04]	-63.23	-63.49	[-77.62—51.07]
	DINOv3	A4C	1277	14.67	14.67	[14.31–15.07]	19.75	20.27	[19.37–22.07]	16.13	16.13	[15.80–16.49]	-73.97	-74.37	[-91.10—59.67]
	SigLIP2	A4C	1277	14.66	14.66	[14.30–15.06]	19.74	20.26	[19.36–22.06]	16.11	16.12	[15.79–16.48]	-73.75	-74.15	[-90.84—59.48]
	EchoPrime with Shuffled frames	A4C	1277	6.12	6.12	[5.79–6.43]	8.24	8.46	[7.91–9.24]	8.36	8.36	[7.90–8.81]	53.18	53.14	[48.50–57.77]
	PanEcho with Shuffled frames	A4C	1277	6.31	6.32	[6.02–6.61]	8.50	8.73	[8.17–9.51]	8.49	8.49	[8.11–8.89]	51.81	51.65	[45.15–57.28]
CAMUS	EchoCLIP	A2C	50	9.85	9.82	[7.87–12.02]	15.39	17.88	[13.46–24.74]	12.25	12.14	[9.83–14.71]	-0.41	-4.72	[-47.33–22.29]
	PanEcho	A2C	50	11.85	11.78	[9.50–14.16]	18.51	21.56	[15.82–30.96]	14.59	14.45	[11.80–17.03]	-42.32	-51.66	[-143.87–8.91]
	BioMedCLIP	A2C	50	17.88	17.85	[14.94–21.43]	27.94	32.54	[25.02–44.12]	21.35	21.18	[17.52–25.68]	-204.71	-218.79	[-340.13—134.36]
	DINOv3	A2C	50	9.88	9.85	[7.56–12.49]	15.43	17.87	[13.34–23.88]	13.32	13.14	[10.04–16.78]	-18.54	-20.84	[-51.18—3.18]
	SigLIP2	A2C	50	9.28	9.25	[7.18–11.54]	14.50	16.79	[12.51–22.29]	12.23	12.09	[9.44–15.17]	-0.06	-2.15	[-11.20—0.01]
	EchoCLIP	A4C	50	10.41	10.41	[8.18–12.77]	16.27	18.93	[14.11–24.90]	13.35	13.25	[10.09–16.45]	-19.20	-23.97	[-66.46–7.91]
	PanEcho	A4C	50	11.95	11.94	[9.52–14.46]	18.67	21.86	[15.68–30.93]	14.99	14.91	[12.03–17.78]	-50.23	-61.26	[-156.34–3.19]
	BioMedCLIP	A4C	50	19.87	19.79	[16.53–23.59]	31.05	36.09	[28.02–49.23]	23.55	23.32	[19.10–28.11]	-270.95	-287.51	[-442.03—178.65]
	DINOv3	A4C	50	9.88	9.85	[7.56–12.49]	15.43	17.87	[13.34–23.88]	13.32	13.14	[10.04–16.78]	-18.55	-20.85	[-51.19—3.19]
	SigLIP2	A4C	50	9.28	9.25	[7.18–11.54]	14.50	16.79	[12.51–22.29]	12.23	12.09	[9.43–15.17]	-0.06	-2.16	[-11.20—0.01]
	EchoCLIP	study-level	50	9.83	9.82	[7.89–11.95]	15.36	17.86	[13.40–23.84]	12.31	12.20	[9.51–14.84]	-1.25	-5.04	[-36.53–19.61]
	EchoPrime	study-level	50	14.00	13.92	[11.33–17.00]	21.88	25.18	[19.14–34.04]	17.37	17.16	[13.64–21.28]	-101.92	-110.04	[-199.12—43.96]
	PanEcho	study-level	50	11.63	11.59	[9.28–14.05]	18.17	21.22	[15.35–29.81]	14.53	14.43	[11.74–17.07]	-41.13	-50.91	[-143.25–9.65]
	BioMedCLIP	study-level	50	18.87	18.81	[15.71–22.48]	29.48	34.30	[26.61–46.82]	22.33	22.13	[18.21–26.79]	-233.33	-248.29	[-387.24—154.42]
	DINOv3	study-level	50	9.88	9.85	[7.56–12.49]	15.43	17.87	[13.34–23.88]	13.32	13.14	[10.04–16.78]	-18.55	-20.84	[-51.18—3.18]
	SigLIP2	study-level	50	9.28	9.25	[7.18–11.54]	14.50	16.79	[12.51–22.29]	12.23	12.09	[9.43–15.17]	-0.06	-2.16	[-11.20—0.01]
EchoNet-Pediatric	EchoCLIP	A4C	271	10.15	10.14	[9.10–11.16]	16.77	17.92	[15.26–21.72]	13.01	12.97	[11.75–14.13]	-125.55	-137.02	[-268.96—51.76]
	EchoPrime	A4C	271	5.59	5.59	[5.01–6.17]	9.23	9.86	[8.49–11.79]	7.54	7.52	[6.59–8.53]	24.16	22.12	[3.85–34.60]
	PanEcho	A4C	271	9.17	9.15	[8.18–10.18]	15.15	16.16	[13.66–19.92]	12.37	12.32	[11.01–13.64]	-104.11	-114.10	[-235.28—32.23]
	BioMedCLIP	A4C	271	16.10	16.10	[15.37–16.92]	26.59	28.44	[25.56–33.18]	17.40	17.39	[16.70–18.15]	-303.44	-324.98	[-531.45—185.29]
	DINOv3	A4C	271	18.21	18.21	[17.58–18.84]	30.08	32.18	[29.28–37.28]	19.03	19.03	[18.45–19.59]	-382.85	-408.85	[-648.17—242.90]
	SigLIP2	A4C	271	18.19	18.19	[17.56–18.82]	30.05	32.14	[29.25–37.24]	19.01	19.01	[18.43–19.57]	-381.92	-407.85	[-646.61—242.28]
	EchoCLIP	PSAX	387	16.35	16.35	[15.24–17.47]	26.93	28.66	[25.41–33.30]	19.55	19.54	[18.46–20.62]	-478.81	-489.65	[-729.94—311.59]
	EchoPrime	PSAX	387	5.34	5.35	[4.87–5.89]	8.79	9.38	[8.18–10.91]	7.42	7.43	[6.47–8.50]	16.66	16.28	[1.29–27.86]
	PanEcho	PSAX	387	9.06	9.05	[8.29–9.85]	14.91	15.86	[13.80–18.96]	12.11	12.09	[11.02–13.17]	-121.99	-125.84	[-223.92—55.67]
	BioMedCLIP	PSAX	387	19.84	19.82	[19.19–20.41]	32.67	34.74	[31.78–39.60]	20.80	20.78	[20.22–21.34]	-555.14	-567.34	[-833.08—368.31]
	DINOv3	PSAX	387	18.26	18.25	[17.71–18.77]	30.07	31.98	[29.38–36.48]	19.08	19.07	[18.60–19.54]	-451.19	-461.42	[-688.79—294.46]
	SigLIP2	PSAX	387	18.24	18.23	[17.69–18.75]	30.04	31.95	[29.35–36.45]	19.06	19.05	[18.58–19.53]	-450.21	-460.42	[-687.34—293.84]
	EchoCLIP	combined	658	13.80	13.79	[13.02–14.63]	22.72	23.23	[21.51–27.02]	17.16	17.15	[16.41–18.01]	-322.17	-331.41	[-461.64—229.56]
	EchoPrime	combined	658	5.44	5.44	[5.07–5.84]	8.96	9.17	[8.40–10.50]	7.47	7.45	[6.78–8.22]	20.01	19.30	[8.61–27.40]
	PanEcho	combined	658	9.10	9.10	[8.47–9.68]	14.99	15.33	[14.02–17.99]	12.22	12.19	[11.35–13.01]	-113.99	-118.30	[-188.76—62.86]
	BioMedCLIP	combined	658	18.30	18.30	[17.81–18.82]	30.13	30.83	[29.42–35.31]	19.47	19.47	[19.03–19.95]	-443.45	-455.89	[-625.26—333.69]
	DINOv3	combined	658	18.24	18.24	[17.84–18.65]	30.03	30.73	[29.41–35.09]	19.06	19.06	[18.71–19.42]	-420.73	-432.63	[-596.67—316.12]
	SigLIP2	combined	658	18.22	18.22	[17.82–18.64]	30.01	30.70	[29.38–35.05]	19.04	19.04	[18.69–19.41]	-419.78	-431.65	[-595.35—315.37]

Table 9: Zero-shot and linear probing performance on CardiacNet-PAH and CardiacNet-ASD tasks with 95% confidence intervals.

				Accuracy (%)			Balanced Accuracy (%)			F1 (%)		
Setting	**Task**	**Model**	n	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**
Zero-shot	PAH	EchoCLIP	106	70.75	70.69	[62.26–79.25]	51.89	51.78	[47.37–57.07]	46.96	46.63	[39.35–55.47]
		BioMedCLIP	106	29.25	29.34	[20.75–37.74]	46.22	46.39	[39.74–52.27]	25.75	25.66	[18.94–33.07]
		DINOv3	106	70.75	70.77	[62.26–79.25]	50.00	50.00	[50.00–50.00]	41.44	41.40	[38.37–44.21]
		SigLIP2	106	30.19	30.14	[22.62–38.68]	50.67	50.64	[50.00–52.11]	24.11	23.94	[18.46–29.62]
	ASD	EchoCLIP	47	53.19	53.04	[38.30–68.09]	59.26	59.16	[52.08–67.86]	47.88	47.13	[33.55–62.78]
		BioMedCLIP	47	51.06	51.35	[38.30–65.96]	45.74	45.96	[37.00–55.31]	40.24	40.02	[29.85–52.16]
		DINOv3	47	57.45	57.47	[42.55–72.34]	50.00	50.00	[50.00–50.00]	36.49	36.35	[29.85–41.98]
		SigLIP2	47	57.45	57.47	[42.55–72.34]	50.00	50.00	[50.00–50.00]	36.49	36.35	[29.85–41.98]
Linear Probing	PAH	EchoCLIP	106	70.75	70.77	[62.26–79.25]	50.00	50.00	[50.00–50.00]	41.44	41.40	[38.37–44.21]
		EchoPrime	106	73.58	73.45	[64.15–82.08]	62.41	62.38	[53.34–72.44]	63.36	63.02	[52.23–74.30]
		PanEcho	106	72.64	72.77	[64.15–82.08]	60.80	61.00	[51.62–70.45]	61.51	61.45	[50.30–72.29]
		BioMedCLIP	106	70.75	70.77	[62.26–79.25]	50.00	50.00	[50.00–50.00]	41.44	41.40	[38.37–44.21]
		EchoFM	106	70.75	70.77	[62.26–79.25]	50.00	50.00	[50.00–50.00]	41.44	41.40	[38.37–44.21]
		DINOv3	106	73.58	73.60	[65.09–81.13]	59.57	59.60	[51.14–68.30]	59.85	59.59	[48.24–70.31]
		SigLIP2	106	72.64	72.68	[64.15–81.13]	53.23	53.25	[50.00–57.81]	47.96	47.83	[40.11–56.56]
	ASD	EchoCLIP	47	57.45	57.47	[42.55–72.34]	50.00	50.00	[50.00–50.00]	36.49	36.35	[29.85–41.98]
		EchoPrime	47	53.19	53.35	[38.30–68.09]	56.02	56.19	[42.39–69.55]	52.66	52.29	[37.28–65.94]
		PanEcho	47	61.70	61.99	[48.94–74.47]	58.89	59.12	[45.98–72.35]	58.53	58.18	[44.05–72.57]
		EchoFM	47	53.19	53.12	[38.30–68.09]	50.83	50.77	[36.97–64.76]	50.48	49.91	[35.05–64.00]
		BioMedCLIP	47	61.70	61.81	[48.88–74.47]	58.89	59.02	[46.10–72.03]	58.53	58.15	[44.29–71.88]
		DINOv3	47	59.57	59.62	[44.68–74.47]	57.04	57.08	[43.43–70.11]	56.76	56.24	[42.12–70.41]
		SigLIP2	47	70.21	70.31	[55.32–82.98]	68.24	68.34	[55.18–81.57]	68.49	68.07	[53.98–81.58]

Table 10: Zero-shot and linear probing performance on HMC-QU dataset. The *View* column indicates the view of the ground truth: HMC-QU includes both A2C and A4C. In the main paper, results are reported at the combined level, but here we additionally provide view-specific results.

				Accuracy (%)			Balanced Accuracy (%)			F1 (%)		
Setting	**Model**	**View**	n	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**
Zero-shot	EchoCLIP	A2C	25	52.00	51.94	[32.00–72.00]	53.85	53.58	[50.00–62.50]	40.48	39.30	[25.00–57.14]
	BioMedCLIP	A2C	25	44.00	44.12	[24.00–64.00]	45.83	45.75	[36.36–50.00]	30.56	30.27	[19.35–39.02]
	DINOv3	A2C	25	48.00	48.20	[28.00–68.00]	50.00	50.00	[50.00–50.00]	32.43	32.20	[21.88–40.48]
	SigLIP2	A2C	25	52.00	51.80	[32.00–72.00]	50.00	50.00	[50.00–50.00]	34.21	33.83	[24.24–41.86]
	EchoCLIP	A4C	25	64.00	63.84	[44.00–84.00]	62.01	61.90	[41.91–81.17]	61.80	60.69	[40.46–80.20]
	BioMedCLIP	A4C	25	56.00	55.71	[36.00–72.10]	50.00	50.00	[50.00–50.00]	35.90	35.52	[26.47–41.89]
	DINOv3	A4C	25	56.00	55.71	[36.00–72.10]	50.00	50.00	[50.00–50.00]	35.90	35.52	[26.47–41.89]
	SigLIP2	A4C	25	44.00	44.29	[27.90–64.00]	50.00	50.00	[50.00–50.00]	30.56	30.38	[21.81–39.02]
	EchoCLIP	combined	50	58.00	57.94	[42.00–72.00]	56.73	56.59	[45.00–67.37]	52.51	51.91	[37.48–66.09]
	BioMedCLIP	combined	50	50.00	50.26	[36.00–64.00]	48.08	48.18	[44.12–50.00]	33.33	33.29	[26.47–39.02]
	DINOv3	combined	50	52.00	52.15	[38.00–66.00]	50.00	50.00	[50.00–50.00]	34.21	34.13	[27.54–39.76]
	SigLIP2	combined	50	48.00	47.85	[34.00–62.00]	50.00	50.00	[50.00–50.00]	32.43	32.20	[25.37–38.27]
Linear Probing	EchoCLIP	A2C	25	76.00	75.70	[56.00–92.00]	75.96	75.58	[55.84–91.88]	75.96	74.83	[55.72–91.88]
	EchoPrime	A2C	25	84.00	83.95	[68.00–96.00]	83.97	83.93	[68.26–96.67]	83.97	83.34	[67.51–96.00]
	PanEcho	A2C	25	68.00	67.66	[48.00–84.00]	67.63	67.28	[48.40–84.75]	67.53	66.25	[47.66–83.77]
	BioMedCLIP	A2C	25	56.00	55.96	[36.00–76.00]	57.05	56.87	[38.78–73.27]	53.31	52.07	[30.56–72.46]
	DINOv3	A2C	25	80.00	79.81	[64.00–96.00]	80.77	80.47	[66.64–94.44]	79.47	78.44	[60.32–95.54]
	SigLIP2	A2C	25	80.00	79.81	[64.00–96.00]	80.77	80.47	[66.64–94.44]	79.47	78.44	[60.32–95.54]
	EchoFM	A2C	25	68.00	67.60	[48.00–84.00]	67.63	67.22	[48.33–84.29]	67.53	66.16	[46.63–83.77]
	EchoCLIP	A4C	25	72.00	71.86	[52.00–88.00]	73.05	72.92	[55.14–88.34]	72.00	71.06	[51.92–87.92]
	EchoPrime	A4C	25	76.00	76.02	[59.90–92.00]	76.62	76.54	[58.76–91.88]	75.96	75.20	[56.00–91.67]
	PanEcho	A4C	25	72.00	72.10	[56.00–88.00]	74.03	74.05	[57.01–88.90]	71.82	71.05	[51.91–87.92]
	EchoFM	A4C	25	76.00	75.84	[60.00–92.00]	77.60	77.33	[62.15–91.67]	75.96	75.03	[59.42–91.67]
	BioMedCLIP	A4C	25	64.00	63.53	[44.00–80.00]	60.06	59.84	[44.73–75.01]	57.14	55.58	[35.89–77.72]
	DINOv3	A4C	25	72.00	71.54	[52.00–88.00]	70.13	69.87	[51.84–86.68]	70.29	68.99	[50.00–86.63]
	SigLIP2	A4C	25	72.00	71.54	[52.00–88.00]	70.13	69.87	[51.84–86.68]	70.29	68.99	[50.00–86.63]
	EchoCLIP	combined	50	74.00	74.05	[62.00–86.00]	74.20	74.24	[61.20–86.04]	73.99	73.64	[60.00–85.86]
	EchoPrime	combined	50	80.00	80.24	[70.00–90.00]	80.13	80.35	[69.80–90.92]	80.00	79.90	[68.78–90.00]
	PanEcho	combined	50	70.00	70.55	[57.95–82.00]	70.51	71.07	[58.33–83.28]	69.70	69.83	[55.93–81.99]
	EchoFM	combined	50	72.00	71.87	[60.00–84.00]	72.44	72.33	[59.93–83.57]	71.82	71.28	[57.98–83.04]
	BioMedCLIP	combined	50	60.00	60.04	[46.00–74.00]	58.81	58.82	[48.00–70.00]	55.44	54.90	[40.26–68.82]
	DINOv3	combined	50	76.00	75.90	[64.00–86.00]	75.32	75.21	[64.00–85.71]	75.00	74.48	[62.49–85.95]
	SigLIP2	combined	50	76.00	75.90	[64.00–86.00]	75.32	75.21	[64.00–85.71]	75.00	74.48	[62.49–85.95]

Table 11: Zero-shot and linear probing performance on TMED-2 dataset. The *View* column indicates the view of the ground truth: TMED-2 includes A2C, A4C, PLAX, PSAX, and Other. In the main paper, results are reported at the study level, but here we additionally provide view-specific results.

			Accuracy (%)			Balanced Accuracy (%)			F1 (%)		
Model	**View**	n	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**
EchoCLIP	A2C	297	94.95	94.93	[92.26–97.31]	50.00	50.00	[50.00–50.00]	48.70	48.70	[47.99–49.32]
PanEcho	A2C	297	84.18	84.16	[80.13–88.22]	66.42	65.95	[52.78–79.18]	57.07	56.72	[49.77–64.29]
BioMedCLIP	A2C	297	94.95	94.93	[92.26–97.31]	50.00	50.00	[50.00–50.00]	48.70	48.70	[47.99–49.32]
DINOv3	A2C	297	94.95	94.93	[92.26–97.31]	50.00	50.00	[50.00–50.00]	48.70	48.70	[47.99–49.32]
SigLIP2	A2C	297	5.05	5.07	[2.69–7.74]	50.00	50.00	[50.00–50.00]	4.81	4.81	[2.62–7.19]
EchoCLIP	A4C	430	94.19	94.25	[92.09–96.28]	50.00	50.00	[50.00–50.00]	48.50	48.52	[47.94–49.05]
PanEcho	A4C	430	82.79	82.84	[78.84–86.28]	75.85	75.75	[65.91–85.75]	60.82	60.61	[54.33–66.72]
BioMedCLIP	A4C	430	94.19	94.25	[92.09–96.28]	50.00	50.00	[50.00–50.00]	48.50	48.52	[47.94–49.05]
DINOv3	A4C	430	94.19	94.25	[92.09–96.28]	50.00	50.00	[50.00–50.00]	48.50	48.52	[47.94–49.05]
SigLIP2	A4C	430	5.81	5.75	[3.72–7.91]	50.00	50.00	[50.00–50.00]	5.49	5.43	[3.59–7.33]
EchoCLIP	PLAX	994	74.75	74.74	[71.93–77.46]	50.00	50.00	[50.00–50.00]	42.77	42.77	[41.84–43.65]
PanEcho	PLAX	994	70.82	70.83	[68.01–73.74]	55.03	55.03	[52.10–57.94]	55.12	55.10	[51.65–58.45]
BioMedCLIP	PLAX	994	74.75	74.74	[71.93–77.46]	50.00	50.00	[50.00–50.00]	42.77	42.77	[41.84–43.65]
DINOv3	PLAX	994	74.75	74.74	[71.93–77.46]	50.00	50.00	[50.00–50.00]	42.77	42.77	[41.84–43.65]
SigLIP2	PLAX	994	25.25	25.26	[22.54–28.07]	50.00	50.00	[50.00–50.00]	20.16	20.16	[18.39–21.92]
EchoCLIP	PSAX	383	83.29	83.32	[79.63–86.68]	50.00	50.00	[50.00–50.00]	45.44	45.44	[44.33–46.43]
PanEcho	PSAX	383	78.59	78.61	[74.41–82.51]	60.29	60.27	[54.36–66.34]	60.55	60.43	[54.38–66.41]
BioMedCLIP	PSAX	383	83.29	83.32	[79.63–86.68]	50.00	50.00	[50.00–50.00]	45.44	45.44	[44.33–46.43]
DINOv3	PSAX	383	83.29	83.32	[79.63–86.68]	50.00	50.00	[50.00–50.00]	45.44	45.44	[44.33–46.43]
SigLIP2	PSAX	383	16.71	16.68	[13.32–20.37]	50.00	50.00	[50.00–50.00]	14.32	14.28	[11.75–16.92]
EchoCLIP	Other	1498	100.00	100.00	[100.00–100.00]	100.00	100.00	[100.00–100.00]	100.00	100.00	[100.00–100.00]
PanEcho	Other	1498	85.85	85.82	[84.04–87.45]	85.85	85.82	[84.04–87.45]	92.39	92.37	[91.33–93.31]
BioMedCLIP	Other	1498	100.00	100.00	[100.00–100.00]	100.00	100.00	[100.00–100.00]	100.00	100.00	[100.00–100.00]
DINOv3	Other	1498	100.00	100.00	[100.00–100.00]	100.00	100.00	[100.00–100.00]	100.00	100.00	[100.00–100.00]
SigLIP2	Other	1498	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
EchoCLIP	study-level	119	78.99	78.85	[71.43–86.55]	50.00	50.00	[50.00–50.00]	44.13	44.06	[41.67–46.40]
EchoPrime	study-level	119	78.99	78.85	[71.43–86.55]	50.00	50.00	[50.00–50.00]	44.13	44.06	[41.67–46.40]
PanEcho	study-level	119	73.95	73.95	[66.37–81.51]	58.55	58.63	[49.32–68.32]	58.91	58.73	[48.91–68.80]
BioMedCLIP	study-level	119	78.99	78.85	[71.43–86.55]	50.00	50.00	[50.00–50.00]	44.13	44.06	[41.67–46.40]
DINOv3	study-level	119	78.99	78.85	[71.43–86.55]	50.00	50.00	[50.00–50.00]	44.13	44.06	[41.67–46.40]
SigLIP2	study-level	119	21.01	21.15	[13.45–28.57]	50.00	50.00	[50.00–50.00]	17.36	17.38	[11.85–22.22]

Table 12: Zero-shot and linear probing performance on SegRWMA dataset. The *View* column indicates the view of the ground truth: SegRWMA includes A2C, A3C, and A4C with 95% confidence intervals.

				Accuracy (%)			Balanced Accuracy (%)			F1 (%)		
Setting	**Model**	**View**	n	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**	**Raw**	**Mean**	**CI**
Zero-shot	EchoCLIP	A2C	48	43.75	43.74	[29.17–58.33]	46.59	47.03	[18.48–74.44]	35.68	35.95	[24.43–50.03]
	PanEcho	A2C	48	33.33	33.56	[20.83–47.92]	52.27	51.77	[15.22–69.57]	30.31	30.50	[19.58–43.79]
	BioMedCLIP	A2C	48	43.75	43.84	[29.17–58.33]	57.95	58.19	[24.99–76.14]	37.66	37.92	[25.81–54.55]
	DINOv3	A2C	48	91.67	91.70	[83.33–97.92]	50.00	50.95	[50.00–50.00]	47.83	48.76	[45.45–49.47]
	SigLIP2	A2C	48	89.58	89.81	[81.25–97.92]	48.86	49.89	[46.51–50.00]	47.25	48.23	[44.83–49.47]
	EchoCLIP	A4C	56	14.29	14.39	[7.14–25.00]	53.85	53.12	[50.93–57.69]	14.29	14.31	[7.02–24.90]
	PanEcho	A4C	56	21.43	21.28	[10.71–32.14]	46.15	45.27	[10.36–62.73]	20.52	20.36	[10.60–31.36]
	BioMedCLIP	A4C	56	7.14	7.34	[1.79–14.29]	50.00	49.25	[50.00–50.00]	6.67	6.75	[1.75–12.50]
	DINOv3	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	SigLIP2	A4C	56	89.29	89.10	[80.36–96.43]	48.08	48.81	[45.19–50.00]	47.17	47.83	[44.55–49.09]
	EchoCLIP	A3C	52	42.31	42.14	[28.85–55.77]	57.29	56.54	[21.00–74.52]	36.27	36.14	[25.36–49.03]
	PanEcho	A3C	52	25.00	25.03	[13.46–36.54]	59.38	58.81	[53.12–65.31]	24.30	24.22	[13.43–35.95]
	BioMedCLIP	A3C	52	34.62	34.73	[23.08–48.08]	64.58	64.12	[58.00–70.93]	32.10	32.12	[21.21–44.85]
	DINOv3	A3C	52	92.31	92.35	[84.62–98.08]	50.00	50.75	[50.00–50.00]	48.00	48.74	[45.83–49.51]
	SigLIP2	A3C	52	92.31	92.30	[84.62–98.08]	72.92	73.18	[46.94–99.00]	72.92	71.56	[46.94–97.03]
Linear Probing	EchoCLIP	A2C	48	91.67	91.70	[83.33–97.92]	50.00	50.95	[50.00–50.00]	47.83	48.76	[45.45–49.47]
	EchoPrime	A2C	48	8.33	8.45	[2.08–16.67]	27.27	26.74	[1.09–53.33]	8.33	8.37	[2.04–16.52]
	PanEcho	A2C	48	91.67	91.55	[83.33–97.92]	72.73	73.26	[46.67–98.91]	72.73	71.37	[46.67–96.80]
	BioMedCLIP	A2C	48	91.67	91.70	[83.33–97.92]	50.00	50.95	[50.00–50.00]	47.83	48.76	[45.45–49.47]
	DINOv3	A2C	48	91.67	91.70	[83.33–97.92]	50.00	50.95	[50.00–50.00]	47.83	48.76	[45.45–49.47]
	SigLIP2	A2C	48	91.67	91.70	[83.33–97.92]	50.00	50.95	[50.00–50.00]	47.83	48.76	[45.45–49.47]
	EchoFM	A2C	48	91.67	91.70	[83.33–97.92]	50.00	50.95	[50.00–50.00]	47.83	48.76	[45.45–49.47]
	EchoCLIP	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	EchoPrime	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	PanEcho	A4C	56	92.86	92.88	[85.71–98.21]	61.54	62.32	[47.27–98.24]	64.78	63.94	[46.67–92.38]
	BioMedCLIP	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	DINOv3	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	SigLIP2	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	EchoFM	A4C	56	92.86	92.66	[85.71–98.21]	50.00	50.75	[50.00–50.00]	48.15	48.83	[46.15–49.55]
	EchoCLIP	A3C	52	92.31	92.35	[84.62–98.08]	50.00	50.75	[50.00–50.00]	48.00	48.74	[45.83–49.51]
	EchoPrime	A3C	52	94.23	94.21	[86.54–100.00]	62.50	62.56	[50.00–100.00]	68.48	65.51	[47.47–100.00]
	PanEcho	A3C	52	90.38	90.44	[80.77–98.08]	48.96	49.70	[46.74–50.00]	47.47	48.21	[44.68–49.51]
	EchoFM	A3C	52	92.31	92.35	[84.62–98.08]	50.00	50.75	[50.00–50.00]	48.00	48.74	[45.83–49.51]
	BioMedCLIP	A3C	52	92.31	92.35	[84.62–98.08]	50.00	50.75	[50.00–50.00]	48.00	48.74	[45.83–49.51]
	DINOv3	A3C	52	92.31	92.35	[84.62–98.08]	50.00	50.75	[50.00–50.00]	48.00	48.74	[45.83–49.51]
	SigLIP2	A3C	52	92.31	92.35	[84.62–98.08]	50.00	50.75	[50.00–50.00]	48.00	48.74	[45.83–49.51]

Table 13: View classification performance with 95% confidence intervals.

Dataset	Model	n	Accuracy (%)			Balanced Accuracy (%)			F1 (%)		
			Raw	Mean	CI	Raw	Mean	CI	Raw	Mean	CI
CAMUS	EchoCLIP	100	49.00	48.76	[39.00–58.00]	49.00	48.97	[46.88–50.00]	33.11	32.92	[28.15–37.01]
	EchoPrime	100	10.00	10.04	[5.00–16.00]	10.00	10.02	[4.89–16.00]	16.39	16.22	[8.33–24.51]
	BioMedCLIP	100	13.00	13.06	[7.00–20.00]	13.00	13.04	[7.00–19.52]	17.02	16.85	[8.98–25.95]
	DINOv3	100	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	SigLIP2	100	4.00	4.04	[1.00–8.00]	4.00	4.02	[0.93–8.49]	6.67	6.61	[1.67–12.91]
EchoNet Dynamic	EchoCLIP	1277	4.46	4.45	[3.37–5.72]	4.46	4.45	[3.37–5.72]	8.55	8.52	[6.52–10.81]
	EchoPrime	1277	97.02	97.03	[96.08–97.96]	97.02	97.03	[96.08–97.96]	98.49	98.49	[98.00–98.97]
	BioMedCLIP	1277	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	DINOv3	1277	0.16	0.16	[0.00–0.39]	0.16	0.16	[0.00–0.39]	0.31	0.31	[0.00–0.78]
	SigLIP2	1277	77.45	77.41	[75.18–79.87]	77.45	77.41	[75.18–79.87]	87.29	87.26	[85.83–88.81]
EchoNet Pediatric	EchoCLIP	658	17.17	17.15	[14.13–20.06]	16.48	16.45	[13.67–19.38]	20.95	20.89	[17.59–24.18]
	EchoPrime	658	67.78	67.75	[64.13–71.28]	66.58	66.55	[62.88–70.39]	79.53	79.48	[76.64–82.32]
	BioMedCLIP	658	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	DINOv3	658	46.81	46.73	[42.86–50.30]	39.85	39.79	[37.53–41.83]	35.82	35.75	[33.83–37.60]
	SigLIP2	658	40.43	40.38	[36.63–44.38]	44.04	44.00	[40.63–47.70]	45.32	45.20	[41.43–49.50]
EchoNet LVH	EchoCLIP	340	0.88	0.89	[0.00–2.06]	0.88	0.89	[0.00–2.06]	1.75	1.76	[0.00–4.03]
	EchoPrime	340	97.35	97.37	[95.59–98.82]	97.35	97.37	[95.59–98.82]	98.66	98.66	[97.74–99.41]
	BioMedCLIP	340	0.29	0.28	[0.00–0.88]	0.29	0.28	[0.00–0.88]	0.59	0.57	[0.00–1.75]
	DINOv3	340	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	SigLIP2	340	17.06	17.03	[13.24–20.88]	17.06	17.03	[13.24–20.88]	29.15	29.05	[23.38–34.55]
CardiacNet	biomedclip$_a sd$	47	12.77	13.01	[4.26–23.40]	12.77	13.01	[4.26–23.40]	22.64	22.70	[8.16–37.93]
	biomedclip$_p ah$	106	83.02	83.01	[75.47–89.62]	83.02	83.01	[75.47–89.62]	90.72	90.67	[86.02–94.53]
	dinov3$_a sd$	47	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	dinov3$_p ah$	106	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	echoclip$_a sd$	47	17.02	16.96	[6.38–27.66]	17.02	16.96	[6.38–27.66]	29.09	28.64	[12.00–43.33]
	echoclip$_p ah$	106	15.09	15.12	[7.55–22.64]	15.09	15.12	[7.55–22.64]	26.23	26.10	[14.04–36.92]
	echoprime$_a sd$	47	59.57	59.31	[44.63–72.34]	59.57	59.31	[44.63–72.34]	74.67	74.19	[61.71–83.95]
	echoprime$_p ah$	106	70.75	70.66	[61.32–79.25]	70.75	70.66	[61.32–79.25]	82.87	82.73	[76.02–88.42]
	sigclip$_a sd$	47	36.17	36.29	[23.40–51.06]	36.17	36.29	[23.40–51.06]	53.12	52.85	[37.93–67.61]
	sigclip$_p ah$	106	38.68	39.06	[30.17–48.13]	38.68	39.06	[30.17–48.13]	55.78	56.00	[46.35–64.99]
HMC-QU	EchoCLIP	50	46.00	45.90	[32.00–60.00]	46.00	45.95	[39.99–50.00]	34.33	34.10	[27.12–40.01]
	EchoPrime	50	82.00	81.92	[70.00–92.00]	82.00	81.90	[70.14–92.00]	88.19	87.92	[79.02–94.89]
	BioMedCLIP	50	48.00	48.05	[34.00–62.00]	48.00	48.08	[34.17–62.66]	47.67	47.16	[33.33–61.98]
	DINOv3	50	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	SigLIP2	50	36.00	36.08	[24.00–50.00]	36.00	36.11	[22.90–49.36]	41.37	40.83	[26.92–56.02]
TMED-2	EchoCLIP	3602	15.74	15.72	[14.60–16.94]	16.57	16.54	[15.20–17.99]	14.25	14.22	[13.10–15.42]
	EchoPrime	3602	61.13	61.12	[59.49–62.69]	76.09	76.06	[74.84–77.20]	62.86	62.84	[61.33–64.32]
	BioMedCLIP	3602	24.99	24.97	[23.63–26.40]	34.90	34.85	[33.04–36.73]	26.37	26.34	[24.98–27.74]
	DINOv3	3602	6.11	6.12	[5.39–6.94]	11.69	11.69	[10.63–12.82]	4.89	4.90	[4.11–5.77]
	SigLIP2	3602	20.63	20.61	[19.32–21.99]	28.22	28.20	[26.73–29.66]	16.17	16.15	[15.03–17.30]
SegRWMA	EchoCLIP	156	25.00	24.99	[18.59–31.41]	23.41	23.33	[18.61–27.91]	16.86	16.71	[12.16–21.37]
	EchoPrime	156	10.26	10.27	[5.77–15.38]	10.36	10.34	[5.86–15.26]	15.79	15.58	[8.95–22.48]
	BioMedCLIP	156	18.59	18.66	[12.18–25.00]	19.54	19.54	[13.58–25.41]	18.41	18.33	[12.97–23.57]
	DINOv3	156	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]	0.00	0.00	[0.00–0.00]
	SigLIP2	156	1.28	1.25	[0.00–3.21]	1.29	1.25	[0.00–3.21]	2.43	2.32	[0.00–5.83]

H SUBGROUP ROBUSTNESS

We assess subgroup robustness by evaluating model performance across demographic and acquisition-related groups. For each group, we report standard regression metrics (MAE, nMAE, MSE, RMSE) along with the sample size. To capture disparities, we add a Δ(max–min) row per grouping, summarizing the gap between the best- and worst-performing groups. This follows the definition of Δ metrics used in classification bias analysis (e.g., ΔAUC Jin et al. (2024)). Together, per-group results show where models underperform, while Δ highlights overall spread. Complete subgroup tables are provided below.

Table 14: Subgroup results by age with per-group raw metrics and a Δ (max−min) summary on CAMUS

Model	View	Group	n	MAE	NMAE (%)	MSE	RMSE	R^2 (%)	Pearson r (%)	Spearman ρ (%)
EchoCLIP	A2C	45	5	13.98	21.84	339.19	18.42	23.78	54.18	30.00
		46–65	20	9.41	26.13	115.02	10.72	-7.87	13.21	10.85
		66–80	20	8.66	25.47	108.84	10.43	-66.71	40.09	41.01
		Δ (max−min)	45	5.32	4.29	230.35	7.99	90.49	40.97	30.16
EchoCLIP	A4C	45	5	15.80	24.69	422.45	20.55	5.08	47.79	70.00
		46–65	20	10.76	29.89	184.87	13.60	-73.38	-22.60	-17.41
		66–80	20	8.39	24.66	102.53	10.13	-57.04	48.52	39.25
		Δ (max−min)	45	7.41	5.23	319.92	10.42	78.46	71.12	87.41
EchoCLIP	combined	45	5	14.89	23.27	369.61	19.23	16.95	53.48	40.00
		46–65	20	9.87	27.42	136.48	11.68	-28.00	-9.44	-3.99
		66–80	20	8.27	24.33	97.57	9.88	-49.44	48.26	40.72
		Δ (max−min)	45	6.62	4.15	272.04	9.35	66.39	62.92	44.71
EchoPrime	combined	45	5	24.00	37.51	853.93	29.22	-91.88	79.39	70.00
		46–65	20	13.82	38.38	288.40	16.98	-170.47	38.72	39.86
		66–80	19	11.70	34.40	188.15	13.72	-185.36	28.34	39.33
		Δ (max−min)	44	12.30	3.98	665.78	15.50	93.48	51.05	30.67
PanEcho	A2C	45	5	16.79	26.24	414.35	20.36	6.90	71.63	60.00
		46–65	20	11.08	30.78	187.46	13.69	-75.81	60.20	64.96
		66–80	20	10.78	31.71	177.42	13.32	-171.74	26.50	24.27
		Δ (max−min)	45	6.01	5.47	236.93	7.04	178.64	45.13	40.69
PanEcho	A4C	45	5	15.59	24.36	315.55	17.76	29.10	71.92	60.00
		46–65	20	12.87	35.74	268.42	16.38	-151.74	43.93	48.76
		66–80	20	10.27	30.22	171.09	13.08	-162.04	27.29	35.58
		Δ (max−min)	45	5.32	11.38	144.46	4.68	191.14	44.63	24.42
PanEcho	combined	45	5	16.19	25.30	352.53	18.78	20.79	73.16	60.00
		46–65	20	11.77	32.70	219.18	14.80	-105.55	54.90	61.64
		66–80	20	10.06	29.59	167.84	12.96	-157.07	28.21	25.25
		Δ (max−min)	45	6.13	7.40	184.69	5.82	177.86	44.95	36.39
BioMedCLIP	A2C	45	5	30.20	47.19	1251.23	35.37	-181.15	-77.99	-70.00
		46–65	20	20.30	56.39	495.97	22.27	-365.14	47.31	53.17
		66–80	20	12.08	35.53	229.56	15.15	-251.60	-29.83	-33.86
		Δ (max−min)	45	18.12	20.86	1021.67	20.22	183.99	125.30	123.17
BioMedCLIP	A4C	45	5	36.32	56.75	1692.82	41.14	-280.37	-86.94	-70.00
		46–65	20	21.39	59.42	566.88	23.81	-431.65	16.14	18.61
		66–80	20	13.88	40.84	270.14	16.44	-313.76	8.56	12.66
		Δ (max−min)	45	22.44	18.58	1422.68	24.70	151.28	103.08	88.61
BioMedCLIP	combined	45	5	33.26	51.97	1455.58	38.15	-227.07	-87.68	-60.00
		46–65	20	20.84	57.90	524.34	22.90	-391.75	41.95	37.91
		66–80	20	12.96	38.11	245.06	15.65	-275.33	-7.23	-9.50
		Δ (max−min)	45	20.30	19.79	1210.52	22.50	164.68	129.63	97.91
DINOv3	A2C	45	5	22.99	35.92	681.69	26.11	-53.18	62.38	80.00
		46–65	20	9.64	26.79	172.84	13.15	-62.10	-33.73	-14.32
		66–80	20	6.50	19.12	65.30	8.08	-0.01	-0.54	-14.78
		Δ (max−min)	45	16.49	16.80	616.39	18.03	62.09	96.11	94.78
DINOv3	A4C	45	5	22.99	35.92	681.77	26.11	-53.19	-41.07	-40.00
		46–65	20	9.65	26.79	172.86	13.15	-62.12	-53.10	-44.31
		66–80	20	6.50	19.12	65.29	8.08	-0.00	16.60	14.85
		Δ (max−min)	45	16.49	16.80	616.48	18.03	62.12	69.70	59.16
DINOv3	combined	45	5	22.99	35.92	681.73	26.11	-53.18	11.22	30.00
		46–65	20	9.64	26.79	172.85	13.15	-62.11	-48.95	-38.36
		66–80	20	6.50	19.12	65.29	8.08	-0.01	8.19	5.35
		Δ (max−min)	45	16.49	16.80	616.44	18.03	62.10	60.17	68.36
SigLIP2	A2C	45	5	20.00	31.25	553.24	23.52	-24.31	-67.48	-60.00
		46–65	20	8.55	23.75	116.54	10.80	-9.30	-0.23	-2.19
		66–80	20	7.60	22.36	89.32	9.45	-36.81	-15.65	-30.46
		Δ (max−min)	45	12.40	8.89	463.92	14.07	27.51	67.25	57.81
SigLIP2	A4C	45	5	20.00	31.25	553.30	23.52	-24.33	-68.40	-60.00
		46–65	20	8.55	23.75	116.55	10.80	-9.30	-18.48	-23.13
		66–80	20	7.60	22.36	89.32	9.45	-36.80	23.32	17.57
		Δ (max−min)	45	12.40	8.89	463.98	14.07	27.50	91.72	77.57
SigLIP2	combined	45	5	20.00	31.25	553.27	23.52	-24.32	-68.18	-60.00
		46–65	20	8.55	23.75	116.55	10.80	-9.30	-12.11	-17.94
		66–80	20	7.60	22.36	89.32	9.45	-36.80	2.59	11.23
		Δ (max−min)	45	12.40	8.89	463.95	14.07	27.50	70.77	71.23

Table 15: Subgroup analysis by gender with per-group raw metrics and a Δ (max$-$min) summary on CAMUS

Model	View	Group	n	MAE	NMAE (%)	MSE	RMSE	R^2 (%)	Pearson r (%)	Spearman ρ (%)
		F	12	11.48	26.69	170.37	13.05	-21.48	14.54	16.81
EchoCLIP	A2C	M	38	9.34	15.06	143.79	11.99	5.59	36.04	34.25
		Δ (max$-$min)	50	2.14	11.63	26.58	1.06	27.07	21.50	17.44
		F	12	8.90	20.70	115.87	10.76	17.38	49.19	62.46
EchoCLIP	A4C	M	38	10.89	17.57	197.99	14.07	-30.00	3.53	0.81
		Δ (max$-$min)	50	1.99	3.13	82.12	3.31	47.38	45.66	61.65
		F	12	9.70	22.57	125.21	11.19	10.72	42.49	30.82
EchoCLIP	combined	M	38	9.87	15.92	159.71	12.64	-4.86	21.50	13.39
		Δ (max$-$min)	50	0.17	6.65	34.50	1.45	15.58	20.99	17.43
		F	12	11.75	27.33	201.08	14.18	-43.38	74.42	66.90
EchoPrime	combined	M	37	14.73	23.76	334.48	18.29	-119.93	39.05	46.49
		Δ (max$-$min)	49	2.98	3.57	133.40	4.11	76.55	35.37	20.41
		F	12	10.08	23.44	164.03	12.81	-16.96	60.71	59.54
PanEcho	A2C	M	38	12.41	20.01	228.27	15.11	-49.88	61.20	54.04
		Δ (max$-$min)	50	2.33	3.43	64.24	2.30	32.92	0.49	5.50
		F	12	9.03	21.00	126.72	11.26	9.64	62.15	62.00
PanEcho	A4C	M	38	12.87	20.76	255.62	15.99	-67.84	57.30	45.96
		Δ (max$-$min)	50	3.84	0.24	128.90	4.73	77.48	4.85	16.04
		F	12	9.48	22.06	141.32	11.89	-0.76	62.16	61.65
PanEcho	combined	M	38	12.31	19.85	233.10	15.27	-53.05	62.33	52.44
		Δ (max$-$min)	50	2.83	2.21	91.78	3.38	52.29	0.17	9.21
		F	12	18.25	42.44	430.01	20.74	-206.62	-48.19	-34.33
BioMedCLIP	A2C	M	38	17.77	28.65	463.85	21.54	-204.56	2.99	8.46
		Δ (max$-$min)	50	0.48	13.79	33.84	0.80	2.06	51.18	42.79
		F	12	22.38	52.05	613.64	24.77	-337.55	-46.79	-21.72
BioMedCLIP	A4C	M	38	19.08	30.78	536.22	23.16	-252.08	-18.42	-1.64
		Δ (max$-$min)	50	3.30	21.27	77.42	1.61	85.47	28.37	20.08
		F	12	20.32	47.25	515.04	22.69	-267.25	-49.75	-32.57
BioMedCLIP	combined	M	38	18.41	29.69	493.32	22.21	-223.91	-10.22	10.97
		Δ (max$-$min)	50	1.91	17.56	21.72	0.48	43.34	39.53	43.54
		F	12	10.58	24.61	161.13	12.69	-14.89	-9.88	-24.17
DINOv3	A2C	M	38	9.65	15.57	182.40	13.51	-19.76	5.44	0.82
		Δ (max$-$min)	50	0.93	9.04	21.27	0.82	4.87	15.32	24.99
		F	12	10.58	24.61	161.13	12.69	-14.89	-9.40	-6.66
DINOv3	A4C	M	38	9.65	15.57	182.41	13.51	-19.77	-11.66	-7.43
		Δ (max$-$min)	50	0.93	9.04	21.28	0.82	4.88	2.26	0.77
		F	12	10.58	24.61	161.13	12.69	-14.89	-11.85	14.01
DINOv3	combined	M	38	9.65	15.57	182.40	13.51	-19.76	-3.73	-6.80
		Δ (max$-$min)	50	0.93	9.04	21.27	0.82	4.87	8.12	20.81
		F	12	9.75	22.67	140.43	11.85	-0.13	-32.29	-41.33
SigLIP2	A2C	M	38	9.13	14.73	152.56	12.35	-0.17	-14.16	-16.06
		Δ (max$-$min)	50	0.62	7.94	12.13	0.50	0.04	18.13	25.27
		F	12	9.75	22.68	140.45	11.85	-0.15	-63.35	-58.14
SigLIP2	A4C	M	38	9.13	14.73	152.56	12.35	-0.17	-21.78	-12.65
		Δ (max$-$min)	50	0.62	7.95	12.11	0.50	0.02	41.57	45.49
		F	12	9.75	22.68	140.44	11.85	-0.14	-60.11	-57.09
SigLIP2	combined	M	38	9.13	14.73	152.56	12.35	-0.17	-21.67	-14.53
		Δ (max$-$min)	50	0.62	7.95	12.12	0.50	0.03	38.44	42.56

Table 16: Subgroup results by image quality with per-group raw metrics and a Δ (max−min) summary on CAMUS

Model	View	Group	n	MAE	NMAE (%)	MSE	RMSE	R^2 (%)	Pearson r (%)	Spearman ρ (%)
EchoCLIP	A2C	Poor	10	5.09	22.13	47.73	6.91	34.49	61.37	42.68
		Medium	21	11.44	24.34	174.26	13.20	-79.98	-9.16	0.65
		Good	19	10.60	16.56	177.47	13.32	18.33	42.97	40.23
		Δ (max−min)	50	6.35	7.78	129.74	6.41	114.47	70.53	42.03
EchoCLIP	A4C	Poor	10	9.14	39.74	104.36	10.22	-43.26	14.89	32.93
		Medium	21	9.75	20.74	171.75	13.11	-77.39	-51.27	-32.20
		Good	19	11.82	18.47	224.40	14.98	-3.27	24.77	10.80
		Δ (max−min)	50	2.68	21.27	120.04	4.76	74.12	76.04	65.13
EchoCLIP	combined	Poor	10	6.28	27.33	55.06	7.42	24.42	50.39	52.44
		Medium	21	10.48	22.29	161.80	12.72	-67.12	-37.96	-22.53
		Good	19	10.98	17.16	190.68	13.81	12.25	36.23	20.47
		Δ (max−min)	50	4.70	10.17	135.62	6.39	91.54	88.35	74.97
EchoPrime	combined	Poor	10	18.93	82.32	430.81	20.76	-491.36	25.48	29.27
		Medium	21	12.53	26.67	234.83	15.32	-142.55	38.87	57.07
		Good	18	12.97	20.27	308.28	17.56	-39.92	53.96	63.57
		Δ (max−min)	49	6.40	62.05	195.98	5.44	451.44	28.48	34.30
PanEcho	A2C	Poor	10	15.22	66.16	336.49	18.34	-361.89	29.20	6.10
		Medium	21	10.40	22.13	160.52	12.67	-65.79	61.09	50.67
		Good	19	11.67	18.24	205.61	14.34	5.38	70.10	64.82
		Δ (max−min)	50	4.82	47.92	175.97	5.67	367.27	40.90	58.72
PanEcho	A4C	Poor	10	13.96	60.71	290.71	17.05	-299.05	39.57	13.41
		Medium	21	10.84	23.07	196.30	14.01	-102.75	48.07	40.42
		Good	19	12.12	18.93	221.31	14.88	-1.85	64.09	51.91
		Δ (max−min)	50	3.12	41.78	94.41	3.04	297.20	24.52	38.50
PanEcho	combined	Poor	10	14.59	63.44	306.62	17.51	-320.89	35.44	16.46
		Medium	21	10.38	22.08	169.52	13.02	-75.09	58.01	47.93
		Good	19	11.46	17.91	206.71	14.38	4.87	69.55	64.21
		Δ (max−min)	50	4.21	45.53	137.10	4.49	325.76	34.11	47.75
BioMedCLIP	A2C	Poor	10	22.18	96.43	535.94	23.15	-635.68	67.17	64.03
		Medium	21	14.39	30.61	284.88	16.88	-194.23	10.68	8.36
		Good	19	19.48	30.44	602.35	24.54	-177.20	-42.40	-40.09
		Δ (max−min)	50	7.79	65.99	317.47	7.66	458.48	109.57	104.12
BioMedCLIP	A4C	Poor	10	23.58	102.52	623.62	24.97	-756.03	28.84	31.19
		Medium	21	15.32	32.59	326.90	18.08	-237.64	-9.95	-22.20
		Good	19	22.96	35.87	770.47	27.76	-254.57	-50.34	-29.60
		Δ (max−min)	50	8.26	69.93	443.57	9.68	518.39	79.18	60.79
BioMedCLIP	combined	Poor	10	22.88	99.48	572.97	23.94	-686.50	69.32	62.08
		Medium	21	14.85	31.60	300.32	17.33	-210.18	-0.23	-7.38
		Good	19	21.19	33.12	678.44	26.05	-212.22	-53.08	-33.55
		Δ (max−min)	50	8.03	67.88	378.12	8.72	476.32	122.40	95.63
DINOv3	A2C	Poor	10	11.49	49.94	204.80	14.31	-181.12	-19.58	-0.61
		Medium	21	6.67	14.19	101.56	10.08	-4.90	-12.23	-11.36
		Good	19	12.57	19.65	246.52	15.70	-13.45	19.76	1.76
		Δ (max−min)	50	5.90	35.75	144.96	5.62	176.22	39.34	13.12
DINOv3	A4C	Poor	10	11.49	49.94	204.80	14.31	-181.13	-25.23	0.61
		Medium	21	6.67	14.19	101.55	10.08	-4.89	10.23	17.83
		Good	19	12.57	19.65	246.56	15.70	-13.46	-19.03	-40.05
		Δ (max−min)	50	5.90	35.75	145.01	5.62	176.24	35.46	57.88
DINOv3	combined	Poor	10	11.49	49.94	204.80	14.31	-181.13	-24.74	12.81
		Medium	21	6.67	14.19	101.56	10.08	-4.89	1.12	2.81
		Good	19	12.57	19.65	246.54	15.70	-13.46	4.84	-7.73
		Δ (max−min)	50	5.90	35.75	144.98	5.62	176.24	29.58	20.54
SigLIP2	A2C	Poor	10	7.70	33.48	115.10	10.73	-58.00	-60.97	-56.10
		Medium	21	8.33	17.73	104.72	10.23	-8.16	3.08	-4.70
		Good	19	11.16	17.43	217.48	14.75	-0.09	-21.48	-38.30
		Δ (max−min)	50	3.46	16.05	112.76	4.52	57.91	64.05	51.40
SigLIP2	A4C	Poor	10	7.70	33.49	115.13	10.73	-58.03	-79.16	-84.15
		Medium	21	8.33	17.73	104.72	10.23	-8.16	16.00	18.41
		Good	19	11.16	17.43	217.49	14.75	-0.09	-28.61	-24.68
		Δ (max−min)	50	3.46	16.06	112.77	4.52	57.94	95.16	102.56
SigLIP2	combined	Poor	10	7.70	33.48	115.11	10.73	-58.02	-81.27	-79.27
		Medium	21	8.33	17.73	104.72	10.23	-8.16	11.13	13.62
		Good	19	11.16	17.43	217.49	14.75	-0.09	-29.85	-29.60
		Δ (max−min)	50	3.46	16.05	112.77	4.52	57.93	92.40	92.89

Table 17: Pediatric subgroup analysis by sex with per-group raw metrics and a Δ (max−min) on EchoNet-Pediatric

Model	View	Group	n	MAE	NMAE (%)	MSE	RMSE	R^2 (%)	Pearson r (%)	Spearman ρ (%)
		F	301	14.39	27.33	316.63	17.79	-462.00	18.86	19.04
EchoCLIP	combined	M	355	13.32	21.99	276.60	16.63	-241.52	32.48	13.21
		Δ (max−min)	656	1.07	5.34	40.03	1.16	220.48	13.62	5.83
		F	301	4.86	9.22	45.92	6.78	18.49	45.49	32.88
EchoPrime	combined	M	355	5.95	9.83	64.43	8.03	20.45	45.76	23.71
		Δ (max−min)	656	1.09	0.61	18.51	1.25	1.96	0.27	9.17
		F	301	8.68	16.49	139.82	11.82	-148.18	44.58	39.47
PanEcho	combined	M	355	9.50	15.69	158.11	12.57	-95.22	49.02	30.58
		Δ (max−min)	656	0.82	0.80	18.29	0.75	52.96	4.44	8.89
		F	301	18.34	34.83	373.58	19.33	-563.08	11.84	7.70
BioMedCLIP	combined	M	355	18.32	30.26	385.46	19.63	-375.93	9.41	6.90
		Δ (max−min)	656	0.02	4.57	11.88	0.30	187.15	2.43	0.80
		F	301	18.48	35.11	367.06	19.16	-551.53	-1.86	-2.74
DINOv3	combined	M	355	18.07	29.86	361.42	19.01	-346.25	-0.23	-7.48
		Δ (max−min)	656	0.41	5.25	5.64	0.15	205.28	1.63	4.74
		F	301	18.46	35.07	366.38	19.14	-550.31	-3.66	1.93
SigLIP2	combined	M	355	18.06	29.83	360.76	18.99	-345.44	-12.81	-3.91
		Δ (max−min)	656	0.40	5.24	5.62	0.15	204.87	9.15	5.84

Table 18: Pediatric subgroup analysis by age bin with per-group raw metrics and a Δ (max−min) on EchoNet-Pediatric.

Model	View	Group	n	MAE	NMAE (%)	MSE	RMSE	R^2 (%)	Pearson r (%)	Spearman ρ (%)
		0–1	55	11.99	22.87	216.65	14.72	-73.40	12.47	10.48
		1–5	121	15.23	65.52	324.21	18.01	-1352.36	22.38	15.09
EchoCLIP	combined	6–12	242	14.56	23.97	324.38	18.01	-257.10	33.82	17.91
		13–18	240	12.73	32.10	267.30	16.35	-388.52	28.88	18.26
		Δ (max−min)	658	3.24	42.65	107.73	3.29	1278.96	21.35	7.78
		0–1	55	7.23	13.79	93.83	9.69	24.90	55.14	32.88
		1–5	121	5.02	21.62	38.78	6.23	-73.72	21.16	11.28
EchoPrime	combined	6–12	242	5.52	9.09	66.42	8.15	26.89	52.03	30.16
		13–18	240	5.17	13.03	44.97	6.71	17.81	44.07	31.70
		Δ (max−min)	658	2.21	12.53	55.05	3.46	100.61	33.98	21.60
		0–1	55	9.82	18.73	174.99	13.23	-40.06	50.22	48.54
		1–5	121	9.81	42.23	167.68	12.95	-651.14	39.05	34.40
PanEcho	combined	6–12	242	9.84	16.20	174.39	13.21	-91.98	50.41	28.56
		13–18	240	7.84	19.77	108.83	10.43	-98.89	46.62	35.39
		Δ (max−min)	658	2.00	26.03	66.16	2.80	611.08	11.36	19.98
		0–1	55	17.21	32.82	355.68	18.86	-184.68	20.90	16.92
		1–5	121	19.80	85.18	428.21	20.69	-1818.25	-6.12	-7.14
BioMedCLIP	combined	6–12	242	18.49	30.45	385.74	19.64	-324.65	9.02	0.68
		13–18	240	17.60	44.39	353.11	18.79	-545.34	12.23	14.48
		Δ (max−min)	658	2.59	54.73	75.10	1.90	1633.57	27.02	24.06
		0–1	55	17.88	34.08	356.39	18.88	-185.24	-3.36	-13.69
		1–5	121	19.87	85.51	417.26	20.43	-1769.21	-1.10	-4.61
DINOv3	combined	6–12	242	18.46	30.40	369.31	19.22	-306.56	-0.02	-6.33
		13–18	240	17.27	43.57	331.58	18.21	-506.00	-0.96	-3.08
		Δ (max−min)	658	2.60	55.11	85.68	2.22	1583.97	3.34	10.61
		0–1	55	17.86	34.05	355.77	18.86	-184.75	13.13	2.56
		1–5	121	19.85	85.43	416.49	20.41	-1765.74	-11.94	-10.97
SigLIP2	combined	6–12	242	18.45	30.37	368.66	19.20	-305.84	-16.46	1.84
		13–18	240	17.26	43.53	330.95	18.19	-504.84	-7.65	-2.36
		Δ (max−min)	658	2.59	55.06	85.54	2.22	1580.99	29.59	13.53

Table 19: Pediatric subgroup analysis by BMI bin with per-group raw metrics and a Δ (max$-$min) on EchoNet-Pediatric.

Model	View	Group	n	MAE	NMAE (%)	MSE	RMSE	R^2 (%)	Pearson r (%)	Spearman ρ (%)
EchoCLIP	combined	Low	345	14.20	23.39	310.80	17.63	-209.39	30.32	21.03
		Healthy	205	13.77	39.68	287.43	16.95	-786.11	16.62	2.60
		High	107	12.57	41.78	257.20	16.04	-624.20	22.98	16.04
		Δ (max$-$min)	657	1.63	18.39	53.60	1.59	576.72	13.70	18.43
EchoPrime	combined	Low	345	5.96	9.82	70.96	8.42	29.37	54.50	35.39
		Healthy	205	4.97	14.31	41.53	6.44	-28.05	9.67	5.84
		High	107	4.64	15.40	34.00	5.83	4.27	42.18	37.61
		Δ (max$-$min)	657	1.32	5.58	36.96	2.59	57.42	44.83	31.77
PanEcho	combined	Low	345	10.41	17.14	190.37	13.80	-89.50	51.27	39.42
		Healthy	205	7.40	21.31	100.68	10.03	-210.37	29.31	23.83
		High	107	8.17	27.13	110.51	10.51	-211.16	35.44	34.95
		Δ (max$-$min)	657	3.01	9.99	89.69	3.77	121.66	21.96	15.59
BioMedCLIP	combined	Low	345	18.40	30.29	385.16	19.63	-283.40	9.24	5.04
		Healthy	205	18.38	52.96	378.86	19.46	-1067.97	9.05	2.05
		High	107	17.93	59.57	363.25	19.06	-922.79	16.51	17.64
		Δ (max$-$min)	657	0.47	29.28	21.91	0.57	784.57	7.46	15.59
DINOv3	combined	Low	345	18.18	29.94	362.89	19.05	-261.23	-2.27	-10.90
		Healthy	205	18.36	52.90	364.33	19.09	-1023.18	-2.51	-1.71
		High	107	18.32	60.88	365.72	19.12	-929.76	6.96	7.37
		Δ (max$-$min)	657	0.18	30.94	2.83	0.07	761.95	9.47	18.27
SigLIP2	combined	Low	345	18.16	29.91	362.25	19.03	-260.60	-15.33	-7.31
		Healthy	205	18.34	52.84	363.60	19.07	-1020.93	2.17	4.39
		High	107	18.31	60.82	365.07	19.11	-927.92	6.62	10.71
		Δ (max$-$min)	657	0.18	30.91	2.82	0.08	760.33	21.95	18.02