A APPENDIX

Table 6: The complete comparison study results on ISIC-2019-LT benchmarks.

ISIC-2019-LT												
Imbalance Ratio	$r = 100$				$r = 200$				$r = 500$			
Methods	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**
ERM	79.00	60.67	38.33	59.33	78.50	56.67	27.00	54.06	78.00	46.67	12.67	45.78
RS	69.50	61.33	49.33	60.06	76.00	62.67	36.33	58.33	78.50	44.00	19.67	47.39
RW	68.00	55.33	53.67	59.00	73.50	54.67	41.33	56.50	62.00	38.00	34.33	44.78
MixUp	78.00	50.67	35.67	54.78	83.00	46.67	21.33	50.33	76.00	48.00	9.00	44.33
Focal	73.50	54.00	44.33	57.28	79.50	53.00	31.00	54.50	83.00	44.00	13.00	46.67
cRT	74.50	59.67	55.67	63.28	81.00	60.00	39.67	60.22	63.50	48.33	28.00	46.61
T-Norm	78.00	53.33	34.00	55.11	83.50	48.67	17.67	49.94	79.50	40.33	3.67	41.17
LWS	72.50	52.67	45.33	56.83	79.50	51.33	32.67	54.50	68.00	43.33	29.67	47.00
KNN	70.00	55.67	58.67	61.44	77.00	51.33	46.67	58.33	75.00	45.33	27.33	49.22
CBLoss	70.00	56.33	61.33	62.56	62.00	59.33	46.67	56.00	55.00	40.33	41.67	45.67
CBLoss_Focal	71.00	57.67	52.67	60.44	72.50	52.00	51.00	58.50	59.50	42.33	43.33	48.39
LADELoss	78.50	52.33	43.67	58.17	84.00	52.33	18.67	51.67	78.50	43.00	14.00	45.17
LDAM	78.50	55.67	41.67	58.61	81.50	52.33	31.00	54.94	76.50	41.33	19.33	45.72
Logits Adjust Loss	80.50	50.67	26.33	52.50	81.00	49.33	12.67	47.67	77.50	36.00	2.67	38.72
Logits Adjust Posthoc	75.00	59.33	49.33	61.22	76.50	50.67	48.00	58.39	72.00	43.67	33.00	49.56
PriorCELoss	65.00	57.00	56.00	59.33	75.00	50.33	48.33	57.89	62.00	52.67	43.33	52.67
RangeLoss	29.50	12.00	0.33	13.94	44.50	9.00	4.00	19.17	46.00	5.67	0.67	17.44
SEQLLoss	78.00	56.33	41.00	58.44	78.00	49.67	27.00	51.56	73.50	45.33	11.33	43.39
VSLoss	80.00	56.33	33.67	56.67	80.50	51.00	28.67	53.39	79.00	47.67	11.00	45.89
WeightedSoftmax	70.50	58.00	48.33	58.94	74.00	59.33	36.00	56.44	73.00	48.67	22.00	47.89
BalancedSoftmax	62.50	54.33	61.00	59.28	77.00	53.67	55.00	61.89	62.00	49.67	41.67	51.11
De-Confound	79.00	52.33	47.67	59.67	82.50	52.67	24.33	53.17	72.50	45.33	9.67	42.50
DisAlign	81.00	60.00	52.33	64.44	78.00	59.67	52.33	63.33	68.50	49.33	37.33	51.72
GCL 1st stage	72.00	56.00	50.33	59.44	78.50	55.33	32.67	55.50	78.00	41.33	31.67	50.33
GCL 2nd stage	57.50	63.33	71.33	64.06	71.00	56.67	64.33	64.00	63.50	55.00	46.00	54.83
MiSLAS	57.50	52.33	57.67	55.83	71.50	48.33	49.67	56.50	63.50	43.00	39.33	48.61
RSG	72.00	35.00	0.00	35.67	78.50	23.33	0.00	33.94	76.00	23.67	0.00	33.22
SADE	34.50	19.33	48.00	33.94	31.50	11.33	52.67	31.83	23.50	13.00	48.33	28.28
SAM	77.50	51.67	26.00	51.72	82.50	50.33	16.33	49.72	76.00	36.00	9.33	40.44
BBN	82.50	58.33	46.00	62.28	76.50	62.33	31.00	54.94	75.50	50.67	19.00	48.39

Table 7: The results on ISIC-2019-LT benchmarks with training epochs of 50 and 200.

ISIC-2019-LT ($r = 100$)								
Training Epochs	50				200			
Methods	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**
ERM	79.00	60.67	38.33	59.33	78.50	54.00	45.00	59.17
RS	69.50	61.33	49.33	60.06	74.50	59.00	53.67	62.39
RW	68.00	55.33	53.67	59.00	78.50	59.00	51.00	62.83
MixUp	78.00	50.67	35.67	54.78	82.50	53.67	42.33	59.50
Focal	73.50	54.00	44.33	57.28	77.00	60.67	43.00	60.22
cRT	74.50	59.67	55.67	63.28	75.50	53.67	55.67	61.61
T-Norm	78.00	53.33	34.00	55.11	82.50	51.67	35.67	56.61
LWS	72.50	52.67	45.33	56.83	76.50	35.00	6.67	39.39
KNN	70.00	55.67	58.67	61.44	73.00	55.33	53.67	60.67
CBLoss	70.00	56.33	61.33	62.56	65.50	56.00	61.33	60.94
CBLoss_Focal	71.00	57.67	52.67	60.44	72.50	55.67	54.33	60.83
LADELoss	78.50	52.33	43.67	58.17	81.00	58.00	44.33	61.11
LDAM	78.50	55.67	41.67	58.61	74.50	59.00	40.00	57.83
Logits Adjust Loss	80.50	50.67	26.33	52.50	77.00	54.33	32.67	54.67
Logits Adjust Posthoc	75.00	59.33	49.33	61.22	76.00	59.00	53.00	62.67
PriorCELoss	65.00	57.00	56.00	59.33	73.00	58.33	56.67	62.67
RangeLoss	29.50	12.00	0.33	13.94	50.00	0.00	0.00	16.67
SEQLLoss	78.00	56.33	41.00	58.44	77.00	55.67	46.00	59.56
VSLoss	80.00	56.33	33.67	56.67	80.50	59.00	41.67	60.39
WeightedSoftmax	70.50	58.00	48.33	58.94	76.50	52.33	48.67	59.17
BalancedSoftmax	62.50	54.33	61.00	59.28	75.00	59.00	49.67	61.22
De-Confound	79.00	52.33	47.67	59.67	81.00	55.67	47.67	61.44
DisAlign	81.00	60.00	52.33	64.44	65.50	58.67	60.67	61.61
GCL 1st stage	72.00	56.00	50.33	59.44	78.50	59.00	56.33	64.61
GCL 2nd stage	57.50	63.33	71.33	64.06	72.50	63.67	63.67	66.61
MiSLAS	57.50	52.33	57.67	55.83	62.00	57.00	58.33	59.11
RSG	72.00	35.00	0.00	35.67	72.00	60.00	51.00	61.00
SADE	34.50	19.33	48.00	33.94	65.00	49.00	47.00	53.67
SAM	77.50	51.67	26.00	51.72	80.50	50.33	33.33	54.72
BBN	82.50	58.33	46.00	62.28	74.00	61.00	53.67	62.89

How training time impacts method effectiveness. Table 7 presents the results for ISIC-2019-LT ($r = 100$) across different methods trained with 50 and 200 epochs. We observed that some methods benefit significantly from extended training; for example, RSG improves from 35.67% AUC at epoch 50 to 61.00% AUC at epoch 200. Conversely, methods like DisAlign exhibit performance degradation with longer training. This suggests potential instability during training and highlights the issue of using an imbalanced validation set to select checkpoints for testing, as discussed in Section 4 of the manuscript. Overall, most methods do not reach optimal performance within 50 epochs, and longer training times may be beneficial for further improvements. However, it is important to emphasize that different methods are designed with varying requirements for learning rates and optimizers depending on different datasets. As such, conclusions based solely on these results may be partial. These findings are intended to offer researchers and engineers guidance on tuning hyperparameters when training with their customized data.

The importance of pre-trained weights initialization. Using ImageNet pre-trained weights as initialization weights is highly beneficial for medical image classification. Despite the huge differences in overall style between domains, ImageNet pretraining offers a common coarse learning representation of texture features and provides a good initialization for optimization convergence. Thus, its benefits will not be further elaborated here. Table 8 presents the performance differences across various methods when using or not using ImageNet for weight initialization. It is worth noting that some methods have modified model structures, making it difficult for these models to leverage ImageNet weights for initialization. However, we would like to emphasize the importance of using well-pretrained models **in practice**, while the results in the table further corroborate this point.

Table 8: The results on ISIC-2019-LT benchmarks w/ and w/o ImageNet pre-training ($r = 100$).

ISIC-2019-LT ($r = 100$)								
Initialized Weights	ImageNet-1K				Random			
Methods	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**
ERM	79.00	60.67	38.33	59.33	73.00	21.33	0.33	31.56
RS	69.50	61.33	49.33	60.06	56.50	33.00	56.00	48.50
RW	68.00	55.33	53.67	59.00	53.00	24.33	36.67	38.00
MixUp	78.00	50.67	35.67	54.78	68.50	19.67	0.67	29.61
Focal	73.50	54.00	44.33	57.28	67.00	27.67	1.00	31.89
cRT	74.50	59.67	55.67	63.28	51.50	31.33	61.67	48.17
T-Norm	78.00	53.33	34.00	55.11	73.50	20.33	0.00	31.28
LWS	72.50	52.67	45.33	56.83	66.00	7.00	0.00	24.33
KNN	70.00	55.67	58.67	61.44	56.50	26.00	33.00	38.50
CBLoss	70.00	56.33	61.33	62.56	46.00	26.33	31.00	34.44
CBLoss_Focal	71.00	57.67	52.67	60.44	48.50	34.00	26.33	36.28
LADELoss	78.50	52.33	43.67	58.17	72.00	23.00	0.00	31.67
LDAM	78.50	55.67	41.67	58.61	71.00	19.00	0.00	30.00
Logits Adjust Loss	80.50	50.67	26.33	52.50	70.50	16.67	0.00	29.06
Logits Adjust Posthoc	75.00	59.33	49.33	61.22	58.50	29.33	33.33	40.39
PriorCELoss	65.00	57.00	56.00	59.33	62.00	28.67	39.33	43.33
RangeLoss	29.50	12.00	0.33	13.94	40.00	12.33	0.00	17.44
SEQLLoss	78.00	56.33	41.00	58.44	73.50	26.67	0.67	33.61
VSLoss	80.00	56.33	33.67	56.67	73.00	20.33	0.00	31.11
WeightedSoftmax	70.50	58.00	48.33	58.94	63.50	30.00	10.00	34.50
BalancedSoftmax	62.50	54.33	61.00	59.28	64.00	29.67	29.67	41.11
De-Confound	79.00	52.33	47.67	59.67	71.50	20.33	0.33	30.72
DisAlign	81.00	60.00	52.33	64.44	50.00	27.67	49.67	42.44
GCL 1st stage	72.00	56.00	50.33	59.44	65.00	21.33	0.00	28.78
GCL 2nd stage	57.50	63.33	71.33	64.06	30.00	12.33	64.00	35.44
MiSLAS	57.50	52.33	57.67	55.83	42.00	14.67	35.00	30.56
RSG	72.00	35.00	0.00	35.67	63.00	50.67	54.33	56.00
SADE	34.50	19.33	48.00	33.94	40.00	19.00	50.33	36.44
SAM	77.50	51.67	26.00	51.72	53.50	13.33	0.00	22.28
BBN	82.50	58.33	46.00	62.28	46.30	46.67	42.74	45.24

Additional details for OOD detection. To assess whether the LTMIC methods improve OOD detection capabilities, we used the OpenOOD codebase (Yang et al., 2022) and evaluated six in-built OOD detection methods. We used the model trained on the Organamnist dataset, using its test set as closed-set samples and ImageNet as OOD samples, each with 1,000 randomly selected images. This task mainly aims to distinguish whether the test sample belongs to known classes from OrganAMNIST or unknown classes from ImageNet. AUROC was used as the evaluation metric for this binary classification. To avoid the impact of retraining models on long-tailed recognition task performance, we selected six post-processing methods, which are as follows: OpenMax (Bendale & Boult, 2016), MSP (Hendrycks & Gimpel, 2016), TS (Guo et al., 2017), ODIN (Liang et al., 2017),

MDS (Lee et al., 2018), and VIM (Wang et al., 2022). We used 0.01 for coreset sampling ratio in OpenMax. For ODIN, temperature is set as 1000 and noise is set as 0.0014.

Table 9: The complete results on MedMNIST and KVASIR benchmarks.

Dataset	BloodMNIST				DermaMNIST				PathMNIST				TissueMNIST			
Methods	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**
ERM	97.27	97.16	82.00	92.14	95.82	61.86	44.08	67.25	98.46	99.64	83.07	93.72	64.38	62.11	23.21	49.90
RS	95.75	99.20	91.17	95.37	91.95	65.75	59.75	72.48	99.26	97.47	86.78	94.50	50.26	64.71	52.88	55.95
RW	97.39	99.04	88.14	94.86	87.32	65.31	69.19	73.94	96.62	99.74	88.57	94.97	59.72	66.15	43.44	56.44
MixUp	98.04	98.93	79.93	92.30	95.90	59.03	54.43	69.78	99.38	99.54	84.72	94.54	65.85	62.79	13.54	47.39
Focal	97.09	99.42	80.75	92.42	95.08	59.60	60.57	71.75	96.38	98.66	87.51	94.18	61.89	63.17	22.07	49.04
cRT	97.64	99.36	87.43	94.81	88.52	73.36	70.09	77.32	93.86	99.69	90.59	94.71	59.47	67.83	38.70	55.33
T-Norm	96.45	97.97	80.79	91.74	95.97	56.76	44.16	65.63	99.47	97.12	85.51	94.03	66.57	52.56	9.82	42.98
LWS	90.30	75.36	1.50	55.72	95.90	25.97	1.73	41.20	98.41	98.30	52.25	82.98	59.28	33.59	0.60	31.16
KNN	93.61	95.88	83.31	90.94	85.31	66.62	59.67	70.53	93.56	99.79	89.67	94.34	54.77	55.40	51.38	53.85
CBLoss	96.92	98.23	85.81	93.65	83.15	63.57	76.61	74.44	97.51	99.64	87.69	94.94	60.38	67.61	43.66	57.21
CBLoss_Focal	96.97	98.34	85.21	93.51	84.41	63.27	73.99	73.89	98.44	99.45	84.10	94.00	58.60	67.08	45.31	56.99
LADELoss	97.16	98.77	72.76	89.56	91.28	67.43	50.60	69.77	98.55	98.48	84.43	93.82	65.96	63.33	23.92	51.07
LDAM	96.74	98.45	87.32	94.17	92.62	63.71	53.15	69.82	97.37	98.66	86.07	94.03	63.31	64.57	14.64	47.51
Logits Adjust Loss	95.41	98.18	51.39	81.66	97.39	52.12	43.63	64.38	99.58	98.58	75.68	91.28	59.79	44.62	1.23	35.21
Logits Adjust Posthoc	96.65	97.91	90.27	94.94	92.62	64.53	61.47	72.87	98.07	99.17	86.19	94.48	59.03	66.35	54.78	60.06
PriorCELoss	96.86	98.02	91.90	95.59	77.63	72.80	70.54	73.66	98.51	97.01	88.97	94.83	55.73	69.21	51.54	58.83
RangeLoss	23.58	6.11	3.69	11.13	100.00	0.00	0.00	33.33	50.00	0.00	0.00	16.67	33.34	0.00	0.00	11.11
SEQLLoss	97.22	97.27	85.27	93.26	89.93	69.13	55.77	71.61	97.53	99.59	88.21	95.11	65.90	62.00	24.12	50.68
VSLoss	96.05	97.70	86.59	93.45	92.84	64.75	49.70	69.10	98.87	98.31	83.46	93.54	66.78	61.45	21.54	49.92
WeightedSoftmax	97.78	98.98	84.65	93.80	87.84	68.31	69.27	75.14	98.83	95.11	85.41	93.12	65.38	68.36	35.57	56.43
BalancedSoftmax	96.55	98.13	90.71	95.13	89.41	67.35	76.61	77.79	96.39	99.54	88.42	94.78	53.86	68.41	52.91	58.39
De-Confound	97.14	97.49	85.10	93.24	95.08	61.54	49.25	68.62	93.45	99.85	88.53	93.94	65.32	61.35	24.34	50.34
DisAlign	97.11	98.98	88.82	94.97	85.68	66.04	75.72	75.81	96.70	97.95	91.85	95.50	50.20	59.73	60.21	56.71
GCL 1st stage	96.98	99.52	90.70	95.74	88.07	65.34	57.95	70.45	96.16	99.89	87.80	94.62	64.44	69.99	33.69	56.04
GCL 2nd stage	96.43	99.47	95.56	97.15	68.75	73.11	90.03	77.30	93.00	99.58	91.79	94.79	48.26	68.48	46.93	54.56
MiSLAS	93.15	99.25	81.74	91.38	65.92	67.53	75.72	69.72	96.30	98.99	88.63	94.64	42.84	64.71	49.91	52.49
RSG	95.45	98.56	86.55	93.52	77.33	53.90	63.12	64.78	96.16	99.95	70.92	89.01	53.08	59.44	0.00	37.51
SADE	60.99	81.91	52.37	65.09	59.36	30.89	58.47	49.57	69.45	95.87	76.96	80.76	45.23	59.76	58.09	54.36
SAM	96.10	97.49	77.40	90.33	93.36	61.02	36.66	63.68	99.30	99.64	86.89	95.28	64.28	69.99	46.93	54.56
BBN	96.24	98.23	89.39	94.62	91.87	70.98	64.02	75.62	98.14	98.95	90.33	95.80	58.62	69.68	43.29	57.19
Dataset	OrganAMNIST				OrganCMNIST				OrganSMNIST				KVASIR			
Methods	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**	**Head**	**Medium**	**Tail**	**Average**
ERM	97.27	97.16	82.00	92.14	93.50	59.20	65.18	72.63	88.33	56.89	66.90	70.71	95.50	93.25	60.33	83.03
RS	95.75	99.20	91.17	95.37	92.49	57.14	64.06	71.23	89.99	52.61	66.39	69.66	95.75	94.50	62.83	84.36
RW	97.39	99.04	88.14	94.86	92.20	68.91	66.84	75.98	83.01	58.68	69.60	70.43	96.75	88.75	67.67	84.39
MixUp	98.04	98.93	79.93	92.30	92.25	57.43	66.97	72.22	89.15	50.09	64.25	67.83	96.25	92.25	55.33	81.28
Focal	97.09	99.42	80.75	92.42	91.98	57.02	63.36	70.79	86.24	54.93	64.77	68.65	95.75	92.00	57.67	81.81
cRT	97.64	99.36	87.43	94.81	92.11	63.17	67.38	74.22	88.23	58.99	69.79	72.34	95.50	88.00	68.83	84.11
T-Norm	96.45	97.97	80.79	91.74	92.17	55.15	63.93	70.42	86.82	54.09	62.73	67.88	98.00	89.75	59.50	82.42
LWS	90.30	75.36	1.50	55.72	44.87	7.82	1.26	17.98	59.44	32.10	23.94	38.49	95.00	87.00	61.67	81.22
KNN	93.63	95.88	83.31	90.94	88.66	56.54	65.97	70.39	85.33	54.82	66.60	68.92	95.00	91.50	67.00	84.50
CBLoss	96.92	98.23	85.81	93.65	94.21	58.69	66.39	73.10	79.87	65.08	73.91	72.96	93.50	90.25	71.00	84.92
CBLoss_Focal	96.97	98.34	85.21	93.51	94.16	57.99	67.36	73.17	84.18	60.42	71.42	72.00	95.00	84.75	71.50	83.75
LADELoss	97.16	98.77	72.76	89.56	91.22	61.58	62.86	71.88	83.32	59.04	64.92	69.09	96.25	90.00	60.83	82.36
LDAM	96.74	98.45	87.32	94.17	90.98	61.68	69.16	73.94	86.07	58.66	68.60	71.11	96.00	89.00	63.17	82.72
Logits Adjust Loss	95.41	98.18	51.39	81.66	91.37	55.47	56.10	67.65	89.31	53.47	56.78	66.52	96.75	93.50	48.17	79.47
Logits Adjust Posthoc	96.65	97.91	90.27	94.94	91.75	62.72	71.24	75.24	82.78	62.01	69.10	71.29	93.00	89.75	70.67	84.47
PriorCELoss	96.86	98.02	91.90	95.59	92.83	64.86	67.17	74.95	86.08	60.96	72.36	73.13	95.50	89.25	70.33	85.03
RangeLoss	23.58	6.11	3.69	11.13	0.00	33.33	0.00	11.11	0.00	33.33	0.00	11.11	0.00	25.50	0.00	8.50
SEQLLoss	97.22	97.27	85.27	93.26	94.52	61.45	65.15	73.71	88.83	55.61	63.84	69.43	97.50	90.50	58.00	82.00
VSLoss	96.05	97.70	86.59	93.45	94.79	61.42	67.08	74.43	86.46	58.66	66.70	70.61	96.75	92.75	62.83	84.11
WeightedSoftmax	97.78	98.98	84.65	93.80	95.06	65.70	69.36	76.70	84.02	60.64	67.67	70.77	95.25	93.25	68.17	85.56
BalancedSoftmax	96.55	98.13	90.71	95.13	93.58	62.68	67.61	74.62	81.44	59.27	70.05	70.26	95.25	88.25	65.83	83.11
De-Confound	97.14	97.49	85.10	93.24	92.56	64.81	64.58	73.98	87.03	61.35	66.07	71.48	96.25	90.50	66.50	84.42
DisAlign	97.11	98.98	88.82	94.97	93.74	62.69	72.65	76.36	88.09	58.77	66.50	71.12	95.75	89.25	68.50	84.50
GCL 1st stage	96.98	99.52	90.70	95.74	94.15	60.46	68.99	74.54	88.64	62.68	73.08	74.80	96.00	93.75	65.67	85.14
GCL 2nd stage	96.43	99.47	95.56	97.15	92.99	64.40	75.42	77.60	81.80	66.23	76.79	74.94	95.25	96.25	66.17	85.89
MiSLAS	93.15	99.25	81.74	91.38	84.86	51.08	64.40	66.78	74.66	52.74	69.39	65.60	94.25	85.75	71.00	83.67
RSG	95.45	98.56	86.55	93.52	86.48	52.89	64.18	67.85	82.77	66.06	70.06	72.96	95.50	91.50	65.33	84.11
SADE	60.99	81.91	52.37	65.09	67.88	46.28	52.30	55.49	72.74	48.62	59.27	60.21	85.75	77.00	43.50	68.75
SAM	96.10	97.49	77.40	90.33	91.34	59.89	64.26	71.83	90.77	56.11	63.36	70.08	97.00	93.25	60.50	83.58
BBN	96.24	98.23	89.39	94.62	91.55	63.41	63.86	72.94	87.91	59.28	71.74	72.98	95.25	89.25	70.00	84.83