

Deep learning for the detection of multiple fundus diseases using ultra-widefield images

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Table S1. Standard diagnostic criteria for nine labels

Labels	Standard diagnostic criteria
Normal fundus	Visible central macular, normal cup-to-disc ratio size, no obvious abnormal optic disc or retinal changes
Referable diabetic retinopathy	One or more fundus conditions such as microaneurysms, retinal hemorrhages, exudates, or cotton wool spots on UWFI, in addition to new vessels on the disc or elsewhere, vitreous hemorrhages, tractional retinal detachment, fibrovascular membrane, or diagnosed based on ultra-widefield fluorescein fundus angiography
Retinal vein occlusion	Patchy and flame-like retinal hemorrhages, tortuous and dilated retinal veins, with or without macular edema or disc edema, accompanied by hard exudate, cotton wool spots and et al
Pathologic myopia	Myopic exceeding -6 diopters and of category 2 to category 4 of the META-PM classification system ¹
Retinal detachment	Grey-green elevation of the retina, with or without visible peripheral retinal degenerations or retinal tears
Age-related macular degeneration	Medium or larger drusen, may be accompanied by hyperpigmentation or hypopigmentation in the macula, with or without geographic atrophy and red intraretinal hemorrhage
Retinitis pigmentosa	Extensive bone spicule-like pigment epithelial hyperplasia surrounding the posterior pole and extending into the middle and far periphery of the fundus, with a waxy pale disc
Vitreous opacity	Vitreous floaters causing small black shadows in front of the retina, with or without visible weiss rings
Optic neuropathy	Optic nerve atrophy: yellowish or pale color of the optic disc; possible glaucomatous optic neuropathy: cup-to-disc ratio >0.6 with or without corresponding nerve fiber layer defects; papilledema or optic disc oedema: bulging edema of the optic disc, blurring of the optic disc border and dilated retinal capillaries

1. Ohno-Matsui K, Kawasaki R, Jonas JB, et al. International photographic classification and grading system for myopic maculopathy. *Am J Ophthalmol* 2015;159:877-883.e877.

Table S2. Performance of EfficientNet-B7 model, DenseNet model and ResNet-101 model on internal test set

Label	EfficientNet-B7					DenseNet					ResNet-101				
	Sensitivity	Specificity	Accurac y	AUC	MCC	Sensitivit y	Specificit y	Accuracy	AUC	MCC	Sensitivit y	Specificit y	Accuracy	AUC	MCC
Normal fundus	0.8916	0.9783	0.9661	0.9811	0.8332	0.8072	0.9803	0.9559	0.9574	0.7904	0.9750	0.9049	0.9251	0.9823	0.8289
	(0.8857, 0.9010)	(0.9780, 0.9801)	(0.9650, 0.9688)	(0.9207, 0.9892)	(0.8493, 0.8633)	(0.8000, 0.8158)	(0.9796, 0.9824)	(0.9537, 0.9575)	(0.8706, 0.9669)	(0.8276, 0.8374)	(0.9724, 0.9779)	(0.9022, 0.9081)	(0.9237, 0.9263)	(0.9257, 0.9942)	(0.8771, 0.8859)
Referable diabetic retinopathy	0.9231	0.9980	0.9881	0.9977	0.8479	0.8333	0.9941	0.9729	0.9766	0.9083	0.9106	0.9976	0.9867	0.9933	0.8341
	(0.9208, 0.9307)	(0.9985, 0.9986)	(0.9875, 0.9900)	(0.9307, 0.9994)	(0.8807, 0.8868)	(0.8269, 0.8417)	(0.9941, 0.9944)	(0.9725, 0.9750)	(0.8720, 0.9855)	(0.9254, 0.9310)	(0.9082, 0.9175)	(0.9972, 0.9986)	(0.9850, 0.9875)	(0.9287, 0.9995)	(0.8387, 0.8600)
Retinal vein occlusion	0.9583	0.9942	0.9898	0.9836	0.9470	0.9444	0.9865	0.9814	0.9861	0.9546	0.8529	0.9890	0.9795	0.9886	0.9547
	(0.9588, 0.9674)	(0.9943, 0.9956)	(0.9875, 0.9900)	(0.9528, 0.9997)	(0.9496, 0.9593)	(0.9439, 0.9540)	(0.9856, 0.9872)	(0.9812, 0.9825)	(0.9384, 0.9718)	(0.9630, 0.9718)	(0.8431, 0.8679)	(0.9879, 0.9906)	(0.9788, 0.9812)	(0.8784, 0.9935)	(0.9474, 0.9600)
Pathologic myopia	0.9643	0.9963	0.9932	0.9968	0.9366	0.9464	0.9906	0.9864	0.9974	0.7534	0.9143	0.9954	0.9867	0.9941	0.7964
	(0.9583, 0.9674)	(0.9959, 0.9972)	(0.9938, 0.9950)	(0.9556, 1.0000)	(0.9492, 0.9569)	(0.9412, 0.9545)	(0.9901, 0.9905)	(0.9862, 0.9875)	(0.9385, 0.9986)	(0.7812, 0.7956)	(0.9062, 0.9211)	(0.9957, 0.9958)	(0.9862, 0.9875)	(0.9278, 0.9918)	(0.8046, 0.8235)
Retinal detachment	0.9636	0.9944	0.9915	0.9982	0.9571	0.9455	0.9925	0.9881	0.9917	0.9256	0.9701	0.9917	0.9887	0.9970	0.9486
	(0.9615, 0.9718)	(0.9932, 0.9945)	(0.9900, 0.9925)	(0.9307, 0.9994)	(0.9605, 0.9673)	(0.9444, 0.9565)	(0.9918, 0.9933)	(0.9862, 0.9888)	(0.9385, 0.9995)	(0.9333, 0.9427)	(0.9623, 0.9722)	(0.9914, 0.9930)	(0.9888, 0.9900)	(0.9661, 0.9987)	(0.9583, 0.9665)
Age-related macular degeneration	0.8667	0.9755	0.9644	0.9708	0.8035	0.8333	0.9679	0.9542	0.9617	0.8499	0.7805	0.9936	0.9846	0.9773	0.7919
	(0.8636, 0.8810)	(0.9736, 0.9763)	(0.9637, 0.9675)	(0.8772, 0.9849)	(0.8250, 0.8380)	(0.8205, 0.8400)	(0.9672, 0.9701)	(0.9513, 0.9563)	(0.9125, 0.9688)	(0.8673, 0.8774)	(0.7647, 0.7931)	(0.9934, 0.9935)	(0.9825, 0.9850)	(0.8728, 0.9812)	(0.8116, 0.8322)
Retinitis pigmentosa	1.0000	1.0000	1.0000	1.0000	1.0000	0.9322	1.0000	0.9932	0.9821	0.9178	1.0000	0.9968	0.9887	0.9969	0.9202
	(1.0000, 1.0000)	(1.0000, 1.0000)	(1.0000, 1.0000)	(1.0000, 1.0000)	(1.0000, 1.0000)	(0.9296, 0.9437)	(1.0000, 1.0000)	(0.9925, 0.9938)	(0.9338, 0.9985)	(0.9265, 0.9379)	(1.0000, 1.0000)	(0.9961, 0.9974)	(0.9888, 0.9900)	(0.9966, 1.0000)	(0.9302, 0.9412)
Vitreous opacity	0.8727	0.9832	0.9729	0.9758	0.8627	0.8727	0.9869	0.9763	0.9717	0.8651	0.7527	0.9921	0.9692	0.9625	0.7093
	(0.8696, 0.8861)	(0.9822, 0.9848)	(0.9725, 0.9738)	(0.8832, 0.9827)	(0.8877, 0.8976)	(0.8667, 0.8889)	(0.9864, 0.9888)	(0.9750, 0.9775)	(0.9234, 0.984)	(0.8854, 0.8969)	(0.7429, 0.7639)	(0.9917, 0.9931)	(0.9688, 0.9712)	(0.8601, 0.9767)	(0.7324, 0.7532)
Optic neuropathy	0.8611	0.9903	0.9746	0.9879	0.9472	0.9306	0.9768	0.9712	0.9809	0.8563	0.6224	0.9943	0.9569	0.9548	0.9265
	(0.8529, 0.8661)	(0.9895, 0.9914)	(0.9738, 0.9762)	(0.8853, 0.9962)	(0.9528, 0.9593)	(0.9231, 0.9405)	(0.9756, 0.9781)	(0.9700, 0.9725)	(0.8851, 0.9845)	(0.8795, 0.8936)	(0.6111, 0.6420)	(0.9932, 0.9945)	(0.9537, 0.9575)	(0.8682, 0.9666)	(0.9405, 0.9507)

AUC, area under the curve; MCC, matthews correlation coefficient.