Effects of Hypertension, Diabetes, and Smoking on Age and Sex Prediction from Retinal Fundus Images

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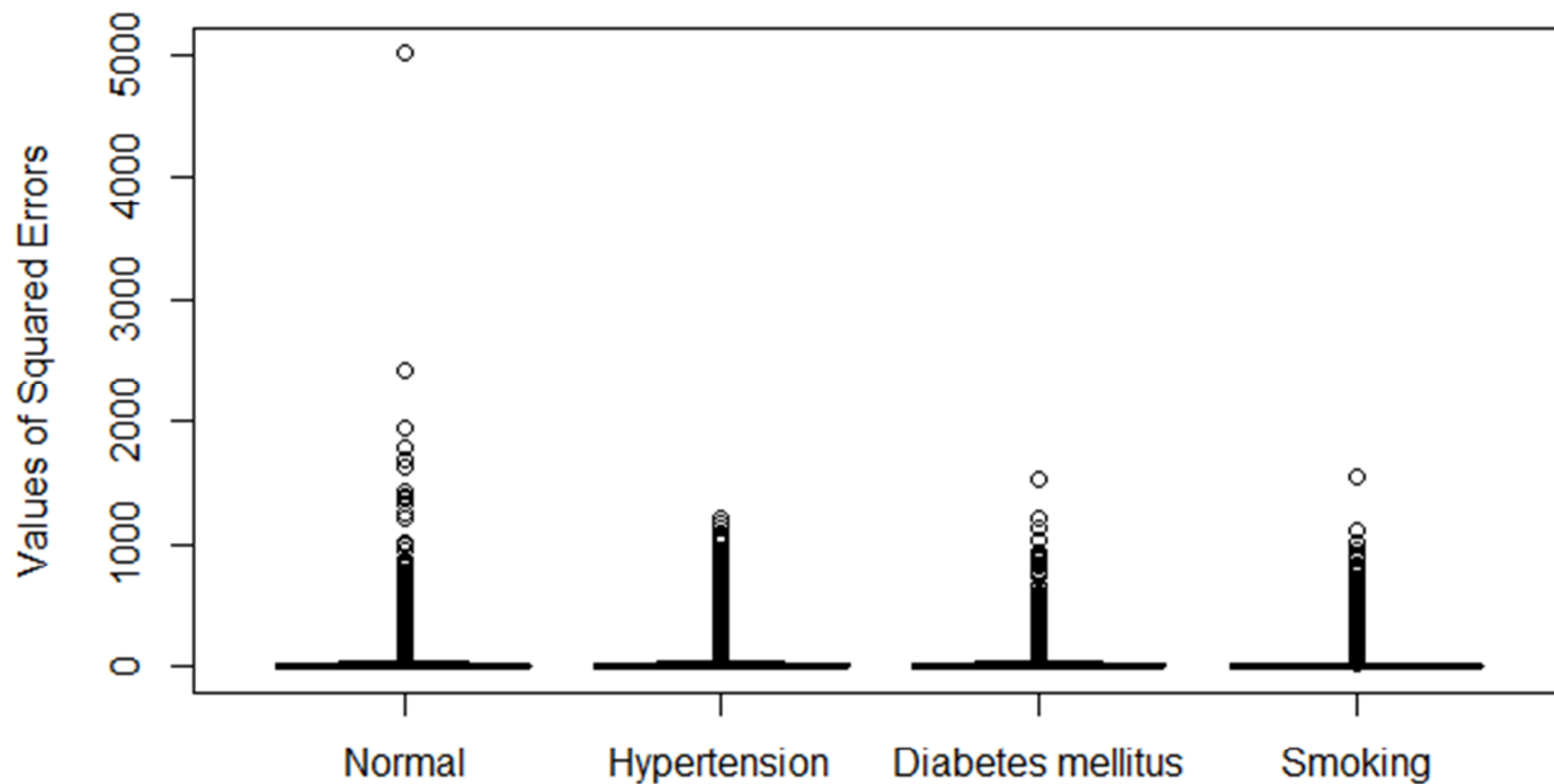[3]School of Electrical Engineering, Kookmin University, Seoul, Republic of Korea

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Supplementary Fig. S1. Box plot of the squared error values in the four test-sets: normal, hypertension, diabetes, and smoking. ANOVA demonstrated significant difference between four test sets.

Supplementary Table S1. Detailed numbers of participants and their retinal fundus images from both right and left eyes according to underlying conditions.

	Participants	Images
Normal	85,639	243,668
Training-set	84,526	216,866
Validation-set	2,397	2,436
Test-set	20,823	24,366
Vascular underlying conditions		
Hypertension	12,168	40,569
Diabetes mellitus	4,545	14,189
Smoking	30,990	113,510
Overlap conditions		
Hypertension & Diabetes mellitus	2,013	7,598
Hypertension & Smoking	6,500	23,165
Diabetes mellitus & Smoking	2,758	9,112
Hypertension & Diabetes mellitus & Smoking	1,285	4,872

Supplementary Table S2. Number and percentage of retinal fundus images according to the age and sex of each test-set.

Age	Normal test-set (N=24,366)		Hypertension test-set (N=40,569)		Diabetes mellitus test-set (N=14,189)		Smoking test-set (N=113,510)	
	Male (N=13,427)	Female (N=10,939)	Male (N=27,389)	Female (N=13,270)	Male (N=10,509)	Female (N=3,680)	Male (N=106,116)	Female (N=7,394)
1	-	2 (0.02%)	-	-	-	-	-	-
2	2 (0.01%)	2 (0.02%)	-	-	-	-	-	-
3	13 (0.10%)	25 (0.23%)	-	-	-	-	-	-
4	52 (0.39%)	69 (0.63%)	-	-	-	-	-	-
5	109 (0.81%)	102 (0.93%)	-	-	-	-	-	-
6	133 (0.99%)	133 (1.22%)	-	-	-	-	-	-
7	96 (0.71%)	139 (1.27%)	-	-	-	-	-	-
8	84 (0.63%)	109 (1.00%)	-	-	-	-	-	-
9	84 (0.63%)	76 (0.69%)	-	-	-	-	-	-
10	63 (0.47%)	52 (0.48%)	-	-	-	-	-	-
11	47 (0.35%)	51 (0.47%)	-	-	-	-	-	-
12	37 (0.28%)	41 (0.37%)	-	-	-	-	-	-
13	25 (0.19%)	26 (0.24%)	-	-	-	-	-	-
14	26 (0.19%)	26 (0.24%)	-	-	-	-	-	-
15	22 (0.16%)	18 (0.16%)	-	-	-	-	-	-
16	19 (0.14%)	24 (0.22%)	-	-	-	-	-	-
17	14 (0.10%)	17 (0.16%)	-	-	-	-	-	-
18	9 (0.07%)	11 (0.10%)	-	-	-	-	-	-
19	6 (0.04%)	10 (0.09%)	-	-	-	-	8 (0.01%)	2 (0.03%)
20	36 (0.27%)	8 (0.07%)	4 (0.01%)	-	-	-	44 (0.04%)	10 (0.14%)
21	36 (0.27%)	25 (0.23%)	2 (0.01%)	-	-	2 (0.05%)	61 (0.06%)	10 (0.14%)
22	20 (0.15%)	25 (0.23%)	6 (0.02%)	-	-	2 (0.05%)	72 (0.07%)	22 (0.30%)
23	26 (0.19%)	21 (0.19%)	4 (0.01%)	-	2 (0.02%)	-	72 (0.07%)	17 (0.23%)
24	23 (0.17%)	28 (0.26%)	4 (0.01%)	2 (0.02%)	-	4 (0.11%)	118 (0.11%)	37 (0.50%)
25	29 (0.22%)	24 (0.22%)	2 (0.01%)	-	2 (0.02%)	-	109 (0.10%)	32 (0.43%)
26	23 (0.17%)	33 (0.30%)	12 (0.04%)	2 (0.02%)	2 (0.02%)	-	150 (0.14%)	49 (0.66%)
27	40 (0.30%)	41 (0.37%)	10 (0.04%)	-	2 (0.02%)	-	201 (0.19%)	49 (0.66%)
28	41 (0.31%)	46 (0.42%)	10 (0.04%)	4 (0.03%)	-	2 (0.05%)	240 (0.23%)	78 (1.05%)
29	50 (0.37%)	66 (0.60%)	20 (0.07%)	2 (0.02%)	-	4 (0.11%)	320 (0.30%)	99 (1.34%)
30	87 (0.65%)	62 (0.57%)	32 (0.12%)	6 (0.05%)	4 (0.04%)	-	489 (0.46%)	120 (1.62%)
31	84 (0.63%)	84 (0.77%)	26 (0.09%)	10 (0.08%)	6 (0.06%)	4 (0.11%)	495 (0.47%)	114 (1.54%)
32	92 (0.69%)	94 (0.86%)	28 (0.10%)	-	4 (0.04%)	10 (0.27%)	583 (0.55%)	140 (1.89%)
33	98 (0.73%)	94 (0.86%)	50 (0.18%)	4 (0.03%)	16 (0.15%)	10 (0.27%)	677 (0.64%)	129 (1.74%)
34	125 (0.93%)	115 (1.05%)	50 (0.18%)	10 (0.08%)	12 (0.11%)	10 (0.27%)	830 (0.78%)	166 (2.25%)
35	142 (1.06%)	125 (1.14%)	78 (0.28%)	4 (0.03%)	12 (0.11%)	10 (0.27%)	995 (0.94%)	182 (2.46%)
36	177 (1.32%)	158 (1.44%)	84 (0.31%)	11 (0.08%)	18 (0.17%)	22 (0.60%)	1,274 (1.20%)	233 (3.15%)
37	227 (1.69%)	185 (1.69%)	127 (0.46%)	16 (0.12%)	46 (0.44%)	16 (0.43%)	1,641 (1.55%)	258 (3.49%)
38	215 (1.60%)	205 (1.87%)	155 (0.57%)	18 (0.14%)	56 (0.53%)	9 (0.24%)	1,843 (1.74%)	279 (3.77%)
39	264 (1.97%)	245 (2.24%)	189 (0.69%)	22 (0.17%)	56 (0.53%)	23 (0.62%)	2,007 (1.89%)	301 (4.07%)

40	299 (2.23%)	289 (2.64%)	251 (0.92%)	48 (0.36%)	103 (0.98%)	26 (0.71%)	2,513 (2.37%)	300 (4.06%)
41	419 (3.12%)	277 (2.53%)	346 (1.26%)	48 (0.36%)	136 (1.29%)	26 (0.71%)	3,127 (2.95%)	258 (3.49%)
42	414 (3.08%)	293 (2.68%)	407 (1.49%)	65 (0.49%)	157 (1.49%)	28 (0.76%)	3,373 (3.18%)	285 (3.85%)
43	484 (3.60%)	295 (2.70%)	519 (1.89%)	94 (0.71%)	172 (1.64%)	43 (1.17%)	3,848 (3.63%)	308 (4.17%)
44	465 (3.46%)	310 (2.83%)	556 (2.03%)	108 (0.81%)	166 (1.58%)	35 (0.95%)	3,713 (3.50%)	259 (3.50%)
45	456 (3.40%)	295 (2.70%)	604 (2.21%)	114 (0.86%)	200 (1.90%)	29 (0.79%)	4,014 (3.78%)	234 (3.16%)
46	472 (3.52%)	320 (2.93%)	693 (2.53%)	104 (0.78%)	262 (2.49%)	36 (0.98%)	4,182 (3.94%)	255 (3.45%)
47	484 (3.60%)	315 (2.88%)	711 (2.60%)	173 (1.30%)	302 (2.87%)	50 (1.36%)	4,215 (3.97%)	256 (3.46%)
48	491 (3.66%)	319 (2.92%)	824 (3.01%)	181 (1.36%)	357 (3.40%)	44 (1.20%)	4,276 (4.03%)	192 (2.60%)
49	489 (3.64%)	301 (2.75%)	939 (3.43%)	222 (1.67%)	384 (3.65%)	48 (1.30%)	4,426 (4.17%)	231 (3.12%)
50	465 (3.46%)	317 (2.90%)	931 (3.40%)	320 (2.41%)	411 (3.91%)	61 (1.66%)	4,221 (3.98%)	242 (3.27%)
51	517 (3.85%)	339 (3.10%)	1,200 (4.38%)	355 (2.68%)	456 (4.34%)	63 (1.71%)	4,970 (4.68%)	205 (2.77%)
52	435 (3.24%)	343 (3.14%)	1,058 (3.86%)	343 (2.58%)	396 (3.77%)	82 (2.23%)	4,085 (3.85%)	183 (2.47%)
53	413 (3.08%)	316 (2.89%)	1,124 (4.10%)	428 (3.23%)	427 (4.06%)	89 (2.42%)	4,107 (3.87%)	213 (2.88%)
54	408 (3.04%)	319 (2.92%)	1,165 (4.25%)	510 (3.84%)	460 (4.38%)	90 (2.45%)	3,986 (3.76%)	198 (2.68%)
55	413 (3.08%)	262 (2.40%)	1,283 (4.68%)	534 (4.02%)	450 (4.28%)	102 (2.77%)	3,893 (3.67%)	165 (2.23%)
56	339 (2.52%)	245 (2.24%)	1,104 (4.03%)	516 (3.89%)	447 (4.25%)	97 (2.64%)	3,380 (3.19%)	156 (2.11%)
57	313 (2.33%)	230 (2.10%)	1,112 (4.06%)	494 (3.72%)	450 (4.28%)	108 (2.93%)	3,153 (2.97%)	140 (1.89%)
58	316 (2.35%)	242 (2.21%)	1,114 (4.07%)	467 (3.52%)	464 (4.42%)	149 (4.05%)	2,934 (2.76%)	136 (1.84%)
59	247 (1.84%)	232 (2.12%)	1,058 (3.86%)	614 (4.63%)	374 (3.56%)	171 (4.65%)	2,464 (2.32%)	110 (1.49%)
60	228 (1.70%)	203 (1.86%)	947 (3.46%)	638 (4.81%)	368 (3.50%)	206 (5.60%)	2,195 (2.07%)	105 (1.42%)
61	214 (1.59%)	192 (1.76%)	934 (3.41%)	591 (4.45%)	352 (3.35%)	110 (2.99%)	2,044 (1.93%)	65 (0.88%)
62	191 (1.42%)	182 (1.66%)	718 (2.62%)	523 (3.94%)	302 (2.87%)	159 (4.32%)	1,732 (1.63%)	88 (1.19%)
63	174 (1.30%)	185 (1.69%)	737 (2.69%)	554 (4.17%)	279 (2.65%)	158 (4.29%)	1,610 (1.52%)	71 (0.96%)
64	148 (1.10%)	165 (1.51%)	648 (2.37%)	538 (4.05%)	308 (2.93%)	179 (4.86%)	1,503 (1.42%)	55 (0.74%)
65	176 (1.31%)	142 (1.30%)	675 (2.46%)	491 (3.70%)	266 (2.53%)	149 (4.05%)	1,415 (1.33%)	52 (0.70%)
66	155 (1.15%)	145 (1.33%)	625 (2.28%)	485 (3.65%)	246 (2.34%)	146 (3.97%)	1,247 (1.18%)	55 (0.74%)
67	118 (0.88%)	151 (1.38%)	589 (2.15%)	395 (2.98%)	214 (2.04%)	130 (3.53%)	1,061 (1.00%)	34 (0.46%)
68	151 (1.12%)	136 (1.24%)	530 (1.94%)	457 (3.44%)	189 (1.80%)	137 (3.72%)	1,030 (0.97%)	30 (0.41%)
69	112 (0.83%)	105 (0.96%)	509 (1.86%)	382 (2.88%)	156 (1.48%)	123 (3.34%)	942 (0.89%)	29 (0.39%)
70	114 (0.85%)	105 (0.96%)	439 (1.60%)	406 (3.06%)	140 (1.33%)	126 (3.42%)	786 (0.74%)	38 (0.51%)
71	84 (0.63%)	108 (0.99%)	338 (1.23%)	312 (2.35%)	157 (1.49%)	75 (2.04%)	642 (0.60%)	25 (0.34%)
72	80 (0.60%)	68 (0.62%)	370 (1.35%)	347 (2.61%)	155 (1.47%)	103 (2.80%)	589 (0.56%)	18 (0.24%)
73	84 (0.63%)	74 (0.68%)	286 (1.04%)	288 (2.17%)	99 (0.94%)	78 (2.12%)	495 (0.47%)	6 (0.08%)
74	76 (0.57%)	80 (0.73%)	232 (0.85%)	208 (1.57%)	79 (0.75%)	61 (1.66%)	396 (0.37%)	19 (0.26%)
75	43 (0.32%)	58 (0.53%)	183 (0.67%)	201 (1.51%)	79 (0.75%)	43 (1.17%)	280 (0.26%)	14 (0.19%)
76	49 (0.36%)	63 (0.58%)	174 (0.64%)	151 (1.14%)	67 (0.64%)	53 (1.44%)	260 (0.25%)	8 (0.11%)
77	38 (0.28%)	68 (0.62%)	155 (0.57%)	130 (0.98%)	69 (0.66%)	37 (1.01%)	215 (0.20%)	6 (0.08%)
78	33 (0.25%)	56 (0.51%)	100 (0.37%)	81 (0.61%)	29 (0.28%)	28 (0.76%)	151 (0.14%)	8 (0.11%)
79	31 (0.23%)	35 (0.32%)	85 (0.31%)	70 (0.53%)	29 (0.28%)	28 (0.76%)	121 (0.11%)	6 (0.08%)
80	19 (0.14%)	22 (0.20%)	42 (0.15%)	58 (0.44%)	28 (0.27%)	8 (0.22%)	74 (0.07%)	7 (0.09%)
81	20 (0.15%)	23 (0.21%)	66 (0.24%)	40 (0.30%)	35 (0.33%)	17 (0.46%)	82 (0.08%)	-
82	8 (0.06%)	23 (0.21%)	35 (0.13%)	24 (0.18%)	20 (0.19%)	13 (0.35%)	45 (0.04%)	-

83	18 (0.13%)	21 (0.19%)	14 (0.05%)	25 (0.19%)	4 (0.04%)	6 (0.16%)	34 (0.03%)	2 (0.03%)
84	10 (0.07%)	10 (0.09%)	16 (0.06%)	10 (0.08%)	7 (0.07%)	-	20 (0.02%)	-
85	13 (0.10%)	17 (0.16%)	21 (0.08%)	9 (0.07%)	4 (0.04%)	-	22 (0.02%)	-
86	10 (0.07%)	2 (0.02%)	14 (0.05%)	-	6 (0.06%)	-	5 (0.00%)	-
87	3 (0.02%)	6 (0.05%)	7 (0.03%)	7 (0.05%)	4 (0.04%)	2 (0.05%)	11 (0.01%)	-
88	4 (0.03%)	8 (0.07%)	4 (0.01%)	-	4 (0.04%)	-	-	-
89	1 (0.01%)	4 (0.04%)	2 (0.01%)	-	-	-	-	-
90	3 (0.02%)	4 (0.04%)	-	-	-	-	-	-
91	2 (0.01%)	1 (0.01%)	2 (0.01%)	-	2 (0.02%)	-	-	-
92	1 (0.01%)	-	-	-	-	-	-	-
93	1 (0.01%)	-	-	-	-	-	-	-
94	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	-
96	-	1 (0.01%)	-	-	-	-	-	-

Supplementary Table S3. Statistical Significance of squared error values ([predicted age-chronologic age]^2) between test-sets (P < 0.05).

Test-set	Normal	Hypertension	Diabetes mellitus	Smoking
Normal		Yes	Yes	Yes
Hypertension	Yes		Yes	Yes
Diabetes mellitus	Yes	Yes		Yes
Smoking	Yes	Yes	Yes	

Yes = statistical significance between groups (ANOVA, Tukey's post hoc test, P < 0.05).