Table 1 Characteristics of the studies included in this meta-analysis

	Auther	Published year	Country	Ethnic	Cases	Number	Diagnosis	Male,n	Mean Age,y	APOE Genotype,number of patients ε2/ε2	ε2/ε3	ε2/ε4	ε3/ε3	ε3/ε4	ε4/ε4	ε2,n	ε3,n	ε4,n
1	Mengel D[1]	2016	Germany	Caucasian	PD	187	Clinical E	NR	NR	3	28	5	111	40	0	39/374	290/374	45/374
					PD-MCI	188	Clinical F	NR	NR	2	28	4	111	41	2	36/376	291/376	49/376
					PDD	72	Clinical G	NR	NR	0	12	3	34	22	1	15/144	102/144	27/144
2	Singh NK[2]	2014	India	Asian	PD A C	70	Clinical E	38	58.01	0	6	1	42	21	0	7/140	111/140	22/140
					Controls	100	Clinical	61	59.71	0	11	1	74	14	0	12/200	173/200	15/200
3	Gregório ML[3]	2013	Brazil	Caucasian	PD	232	Clinical H	144	69.2	0	19	1	169	37	6	20/464	394/464	50/464
					Controls	137	Clinical	66	71.7	0	8	0	103	24	2	8/274	238/274	28/274
4	Dong X [4]	2013	China	Asian	PD	36	Clinical E	NR	NR	2	3	0	24	6	1	7/72	57/72	8/72
					PDD	15	Clinical I	13	71.2	0	1	0	10	3	1	1/30	24/30	5/30
					Controls	52	Clinical	33	69.4	4	9	0	35	4	0	17/104	83/104	4/104

5	Pulkes T [5]	2011	Thailand	Asian	PD [A]	155	Clinical [E]	88	61.2	2	28	2	97	23	3	34/310	245/310	31/310
					Controls	158	Clinical	NR	> 65	1	15	2	103	36	1	19/316	257/316	40/316
6	Kiyohara C [6]	2011	Japan	Asian	PD	238	Clinical [E]	91	68.5	1	21	7	164	43	2	30/476	392/476	54/476
					Controls	296	Clinical	114	69.7	0	21	1	218	56	0	22/592	513/592	57/592
7	Gao J [7]	2011	USA	Caucasian	PD	786	Clinical [E]	600	NR	6	100	14	522	133	11	126/1572	1277/1572	169/1572
					Controls	1537	Clinical	1211	NR	12	198	34	952	316	25	256/3074	2418/3074	400/3074
8	Vefring H [8]	2010	Norway	Caucasian	PD	203	Clinical [H]	120	68.2	NR	NR	NR	NR	NR	NR	21/406	311/406	74/406
					Controls	187	Clinical	99	66.2	NR	NR	NR	NR	NR	NR	19/374	293/374	62/374
9	Ryu HG [9]	2010	Korea	Asian	PD [A]	234	Clinical [H]	68	71.1	1	24	2	173	34	0	28/468	404/468	36/468
					Controls	192	Clinical	97	72.2	0	20	1	147	24	0	21/384	338/384	25/384
10	Williams-G ray CH [10]	2009	UK	Caucasian	PD	505	Clinical [E]	303	NR	4	63	13	311	107	7	84/1010	792/1010	134/1010

					Controls	478	Clinical	229	NR	5	54	15	277	117	10	79/956	725/956	152/956
11	Kurz MW[11]	2009	Norway	Caucasian	PD	95	Clinical [E] +Pathologic	NR	NR	3	10	2	49	24	7	18/190	132/190	40/190
					Controls	73	Clinical	NR	NR	4	3	2	43	20	1	13/146	109/146	24/146
12	Gallegos-Arreola MP[12]	2009	Mexico	Caucasian	PD	105	Clinical [H]	63	63	4	3	2	55	40	1	13/210	153/210	44/210
					Controls	107	Clinical	47	50	1	0	3	86	17	0	5/214	189/214	20/214
13	Ezquerra M[13]	2008	Spain	Caucasian	PD	138	Clinical [E]	66	NR	0	11	0	101	26	0	11/276	239/276	26/276
					PDD	86	Clinical [J]	50	NR	0	7	1	57	20	1	8/172	141/172	23/172
					Controls	91	Clinical	40	NR	0	7	3	64	17	0	10/182	152/182	20/182
14	Papapetro-poulos S[14]	2007	USA	Caucasian	PD	118	Clinical [E] +Pathologic	85	77	2	11	4	68	33	0	19/236	180/236	37/236

					Controls	91	Clinical	43	79.1	0	9	1	68	13	0	10/182	158/182	14/182
15	López M[15]	2007	Mexico	Caucasian	PD	229	Clinical [H]	138	62.28	0	19	1	156	50	3	20/458	381/458	57/458
					Controls	229	Clinical	138	63.97	0	15	2	179	32	1	17/458	405/458	36/458
16	Jasinska-Myga B[16]	2007	Poland	Caucasian	PD [A]	100	Clinical [E]	52	62	1	8	7	56	25	3	17/200	145/200	38/200
					PDD [A]	98	Clinical [K]	47	71	1	11	3	56	24	3	16/196	147/196	33/196
17	Buchanan DD[17]	2007	Australia	Caucasian	PD	422	Clinical [H]	239	66.95	1	51	9	258	90	13	62/844	657/844	125/844
					Controls	387	Clinical	114	64.16	1	37	11	232	95	11	50/774	596/774	128/774
18	Tröster AI[18]	2006	USA	Caucasian	PD	62	Clinical [H]	44	NR	1	6	4	35	13	3	12/124	89/124	23/124
					Controls	146	Clinical	72	71.5	2	15	2	85	40	2	21/292	225/292	46/292
19	Ghebremed-hin E[19]	2006	Germany	Caucasian	PD	108	Clinical [H] +Pathologic	62	75.1	6	5	5	58	24	10	22/216	145/216	49/216

					Controls	108	Clinical+ Pathologic	62	75.1	1	7	6	70	21	3	15/216	168/216	33/216
20	Blázquez L[20]	2006	Spain	Caucasian	PD A	185	Clinical H	101	72	NR	NR	NR	NR	NR	NR	25/370	330/370	15/370
					PD B	91	Clinical H	61	69.3	NR	NR	NR	NR	NR	NR	9/182	156/182	17/182
					Controls	212	Clinical	110	70.9	NR	NR	NR	NR	NR	NR	30/424	356/424	38/424
					PD A C	159	Clinical H	NR	NR	NR	NR	NR	NR	NR	NR	24/318	282/318	12/318
					PD A D	26	Clinical H K	NR	NR	NR	NR	NR	NR	NR	NR	1/52	48/52	3/52
21	Camicio-li R[21]	2005	Canada	Caucasian	PD	19	Clinical H +Pathologic	11	63.3	NR	NR	NR	NR	NR	NR	1/38	34/38	3/38
					PDD	28	Clinical I +Pathologic	22	61.8	NR	NR	NR	NR	NR	NR	3/56	43/56	10/56
22	Zhou CW[22]	2004	China	Asian	PD A C	36	Clinical H	NR	NR	2	3	0	24	6	1	7/72	57/72	8/72

					PDD [A]	15	Clinical [I]	13	71.2	0	1	0	10	3	1	1/30	24/30	5/30
					Controls	52	Clinical	33	69.4	4	9	0	35	4	0	17/104	83/104	4/104
23	Zhao XP[23]	2003	China	Asian	PD	68	Clinical [H]	40	63	0	4	5	48	11	0	9/136	111/136	16/136
					Controls	110	Clinical	59	68	3	13	2	75	16	1	21/220	179/220	20/220
24	Schulte T[24]	2003	Germany	Caucasian	PD	382	Clinical [E]	NR	NR	0	51	16	230	71	14	67/764	582/764	115/764
					Controls	306	Clinical	NR	NR	1	40	5	184	69	7	47/612	477/612	88/612
25	Tang G[25]	2002	China	Asian	PD [A]	68	Clinical [H]	35	65.61	0	4	5	48	11	0	9/136	111/136	16/136
					Controls	160	Clinical	76	55.81	6	12	1	110	29	2	25/320	261/320	34/320
26	Parsian A[26]	2002	USA	Caucasian	PD [A]	166	Clinical [E]	NR	68	NR	NR	NR	NR	NR	NR	19/332	279/332	34/332
					PD#	118	Clinical [E]	NR	67	NR	NR	NR	NR	NR	NR	11/236	201/236	24/236
					Controls	94	Clinical	NR	62	NR	NR	NR	NR	NR	NR	11/188	163/188	14/188
27	Eerola J[27]	2002	Finland	Caucasian	PD [A C]	147	Clinical [E]	87	67.2	1	17	3	82	40	4	22/294	221/294	51/294

					Controls	137	Clinical	50	65.8	1	14	6	70	42	4	22/274	196/274	56/274
28	Wang F[28]	2001	China	Asian	PD	40	Clinical [H]	28	66.13	0	1	0	35	4	0	1/80	75/80	4/80
					PDD	11	Clinical [I]	7	71.09	0	1	0	6	4	0	1/22	17/22	4/22
					Controls	52	Clinical	30	65.5	0	3	0	42	7	0	3/104	94/104	7/104
29	Hao YX[29]	2001	China	Asian	PD	64	Clinical [H]	37	63	0	6	4	40	14	0	10/128	100/128	18/128
					Controls	101	Clinical	53	62	3	6	2	76	13	1	14/202	171/202	17/202
30	Zeng XY[30]	2000	China	Asian	PD	54	Clinical [H]	37	68.2	0	2	1	48	3	0	3/108	101/108	4/108
					PDD	43	Clinical [I]	31	78.6	0	0	0	38	5	0	0/86	81/86	5/86
					Controls	234	Clinical	158	59.2	2	24	1	188	15	4	29/468	415/468	24/468
31	Harhangi BS[31]	2000	Netherlands	Caucasian	PD	81	Clinical [H]	30	76	0	14	2	51	13	1	16/162	129/162	17/162
					PDD	26	Clinical [I]	8	82	1	8	1	7	9	0	11/52	31/52	10/52
32	Zhang JH[32]	1999	China	Asian	PD	72	Clinical [H]	NR	NR	0	32	10	23	7	0	42/144	85/144	17/144

					Controls	66	Clinical	NR	NR	0	39	9	14	4	0	48/132	71/132	13/132
33	Oliveri RL[33]	1999	Italy	Caucasian	PD [A]	126	Clinical [E]	72	NR	0	6	7	99	14	0	13/252	218/252	21/252
					Controls	119	Clinical	57	NR	0	10	7	91	10	1	17/238	202/238	19/238
34	Bon MA[34]	1999	Nether-lands	Caucasian	PD	50	Pathologic	NR	NR	NR	NR	NR	NR	NR	NR	12/100	69/100	19/100
					Controls	95	Pathologic	NR	NR	NR	NR	NR	NR	NR	NR	13/190	153/190	24/190
35	Qin B[35]	1998	China	Asian	PD	36	Clinical [H]	24	66.6	0	1	0	33	2	0	1/72	69/72	2/72
					PDD	32	Clinical [I]	23	80.1	0	0	0	29	3	0	0/64	61/64	3/64
					Controls	60	Clinical	55	68.1	0	3	0	53	3	1	3/120	112/120	5/120
36	NR[36]	1997	France	Caucasian	PD [A C]	46	Clinical [H]	27	65	0	12	0	26	8	0	12/92	72/92	8/92
					PD [B C]	57	Clinical [H]	29	65	1	8	0	40	8	0	10/114	96/114	8/114
					Controls	387	Clinical	215	67	2	43	6	239	92	5	53/774	613/774	108/774
37	Ballering	1997	Nether-	Caucasian	PD [C]	50	Clinical [H]	NR	NR	1	8	2	22	17	0	12/100	69/100	19/100

	LA[37]		lands															
					Controls	107	Clinical	NR	NR	1	14	3	61	25	3	19/214	161/214	34/214
38	Whitehead AS[38]	1996	Ireland	Caucasian	PD	189	Clinical [E]	123	NR	0	26	5	111	44	3	31/378	292/378	55/378
					Controls	162	Clinical	101	NR	0	19	1	102	38	2	20/324	261/324	43/324
39	Rubins-ztein DC[39]	1994	UK	Caucasian	PD [A C]	34	Clinical [H]	26	57	0	8	1	19	6	0	9/68	52/68	7/68
					Controls	34	Clinical	26	57	0	2	1	21	10	0	3/68	54/68	11/68

Abbreviations: NR,Not Reported; PD,Parkinson's disease; PDD,Parkinson's disease dementia; Controls,Healthy individuals.

[A],Sporadic; [B],Familial; [C],Without dementia; [D],With dementia; [E],UK Parkinson's Disease Society Brain Bank clinical diagnostic criteria; [F],Petersen criteria; [G],Level II Movement Disorder Society task force criteria;

[H],Based on clinical symptoms, levodopa-responsiveness and neuroimaging method; [I],DSM-Ⅲ-R; [J],Based on the 2007 Turkish diagnostic criteria; [K],Based on MMSE score and NINCDS-ADRDA

Reference Number

[1] Mengel D, Dams J, Ziemek J, et al. Apolipoprotein E epsilon4 does not affect cognitive performance in patients with Parkinson's disease[J]. Parkinsonism & related disorders. 2016;29:112-6.

[2] Singh NK, Banerjee BD, Bala K, et al. APOE and LRPAP1 gene polymorphism and risk of Parkinson's disease[J]. Neurological sciences : official journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology. 2014;35(7):1075-81.

[3] Gregorio ML, Pinhel MA, Sado CL, et al. Impact of genetic variants of apolipoprotein E on lipid profile in patients with Parkinson's disease[J]. BioMed research international. 2013;2013:641515.

[4] Xiang D. Apolipoprotein E polymorphism and the risk of Alzheimer's disease and Parkinson's disease[J]. Guide of China Medicine. 2013;1671-8194(24):206-,7.

[5] Pulkes T, Papsing C, Mahasirimongkol S, et al. Association between apolipoprotein E genotypes and Parkinson's disease[J]. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia. 2011;18(10):1333-5.

[6] Kiyohara C, Miyake Y, Koyanagi M, et al. APOE and CYP2E1 polymorphisms, alcohol consumption, and Parkinson's disease in a Japanese population[J]. Journal of neural transmission. 2011;118(9):1335-44.

[7] Gao J, Huang X, Park Y, et al. Apolipoprotein E genotypes and the risk of Parkinson disease[J]. Neurobiology of aging. 2011;32(11):2106 e1-6.

[8] Vefring H, Haugarvoll K, Tysnes OB, et al. The role of APOE alleles in incident Parkinson's disease. The Norwegian ParkWest Study[J]. Acta neurologica Scandinavica. 2010;122(6):438-41.

[9] Ryu HG, Kwon OD. Apolipoprotein E epsilon 4 allele is not associated with age at onset or MMSE of Parkinson's disease in a Korean study[J]. Parkinsonism & related disorders. 2010;16(9):615-7.

[10] Williams-Gray CH, Goris A, Saiki M, et al. Apolipoprotein E genotype as a risk factor for susceptibility to and dementia in Parkinson's disease[J]. Journal of neurology. 2009;256(3):493-8.

[11] Kurz MW, Dekomien G, Nilsen OB, et al. APOE alleles in Parkinson disease and their relationship to cognitive decline: a population-based, longitudinal study[J]. Journal of geriatric psychiatry and neurology. 2009;22(3):166-70.

[12] Gallegos-Arreola MP, Figuera LE, Ortiz GG, et al. Apolipoprotein E genotypes in Mexican patients with Parkinson's disease[J]. Disease markers. 2009;27(5):225-30.

[13] Ezquerra M, Campdelacreu J, Gaig C, et al. Lack of association of APOE and tau polymorphisms with dementia in Parkinson's disease[J]. Neuroscience letters. 2008;448(1):20-3.

[14] Papapetropoulos S, Farrer MJ, Stone JT, et al. Phenotypic associations of tau and ApoE in Parkinson's disease[J]. Neuroscience letters. 2007;414(2):141-4.

[15] Lopez M, Guerrero J, Yescas P, et al. Apolipoprotein E epsilon4 allele is associated with Parkinson disease risk in a Mexican Mestizo population[J]. Movement disorders : official journal of the Movement Disorder Society. 2007;22(3):417-20.

[16] Jasinska-Myga B, Opala G, Goetz CG, et al. Apolipoprotein E gene polymorphism, total plasma cholesterol level, and Parkinson disease dementia[J]. Archives

of neurology. 2007;64(2):261-5.

[17] Buchanan DD, Silburn PA, Prince JA, et al. Association of APOE with Parkinson disease age-at-onset in women[J]. Neuroscience letters. 2007;411(3):185-8.

[18] Troster AI, Fields JA, Paolo AM, et al. Absence of the apolipoprotein E epsilon4 allele is associated with working memory impairment in Parkinson's disease[J]. Journal of the neurological sciences. 2006;248(1-2):62-7.

[19] Ghebremedhin E, Del Tredici K, Vuksic M, et al. Relationship of apolipoprotein E and age at onset to Parkinson disease neuropathology[J]. Journal of neuropathology and experimental neurology. 2006;65(2):116-23.

[20] Blazquez L, Otaegui D, Saenz A, et al. Apolipoprotein E epsilon4 allele in familial and sporadic Parkinson's disease[J]. Neuroscience letters. 2006;406(3):235-9.

[21] Camicioli R, Rajput A, Rajput M, et al. Apolipoprotein E epsilon4 and catechol-O-methyltransferase alleles in autopsy-proven Parkinson's disease: relationship to dementia and hallucinations[J]. Movement disorders : official journal of the Movement Disorder Society. 2005;20(8):989-94.

[22] Zhou Chang-wen XJ-t, Gui Jun-hao. Association between Polymorphism of Apolipoprotein E Gene and Parkinson's Disease[J]. CARCINOGENESIS,TERATOGENESIS AND MUTAGENESIS. 2004;1004-616X(chi):3.

[23] Xiao-Ping Zhao W-WZ, Jun Feng, Hui-Jun Xie. Relationship of apolipoprotein E gene polymorphism to Parkinson's disease and Alzheimer's disease[J]. CHINESE JOURNAL OF CLINICAL REHABILITATION. 2003(31):2.

[24] Schulte T, Bohringer S, Schols L, et al. Modulation of disease risk according to a cathepsin D / apolipoprotein E genotype in Parkinson's disease[J]. Journal of neural transmission. 2003;110(7):749-55.

[25] Tang G, Xie H, Xu L, et al. Genetic study of apolipoprotein E gene, alpha-1 antichymotrypsin gene in sporadic Parkinson disease[J]. American journal of medical genetics. 2002;114(4):446-9.

[26] Parsian A, Racette B, Goldsmith LJ, et al. Parkinson's disease and apolipoprotein E: possible association with dementia but not age at onset[J]. Genomics. 2002;79(3):458-61.

[27] Eerola J, Launes J, Hellstrom O, et al. Apolipoprotein E (APOE), PARKIN and catechol-O-methyltransferase (COMT) genes and susceptibility to sporadic Parkinson's disease in Finland[J]. Neuroscience letters. 2002;330(3):296-8.

[28] Wang Fen LM-L, Yang Zhi-Jie. Analysis the polymorphism of apolipoprotein E gene in patients of parkinson disease with dementia[J]. MODERN REHABILITATION. 2001(3):2.

[29] Hao Y, Xie H, Xu L. [Association between polymorphism of alpha 1-antichymotrypsin and apolipoprotein E gene and Parkinson's disease in Shanghai Hans][J]. Zhonghua yi xue za zhi. 2001;81(19):1172-5.

[30] Zeng Xiangyu GH, Qin Bin. The study of relationship between Alzheimer's and Parkinson's disease with dementia and apolipoprotein E polymorphism[J]. CHINESE GENERAL PRACTICE. 2000;1007-9572(5):3.

[31] Harhangi BS, de Rijk MC, van Duijn CM, et al. APOE and the risk of PD with or without dementia in a population-based study[J]. Neurology. 2000;54(6):1272-6.

[32] Zhang Jun-Hui PY-H, Li Jing-Ru CLINICAL SIGNIFICANCE OF EYE MOVEMENT ABNORMALITY IN BRAIN STEM LESION[J]. JOURNAL OF CLINICAL NEUROLOGY. 1999(1999,3):3.

[33] Oliveri RL, Nicoletti G, Cittadella R, et al. Apolipoprotein E polymorphisms and Parkinson's disease[J]. Neuroscience letters. 1999;277(2):83-6.

[34] Bon MA, Jansen Steur EN, de Vos RA, et al. Neurogenetic correlates of Parkinson's disease: apolipoprotein-E and cytochrome P450 2D6 genetic polymorphism[J]. Neuroscience letters. 1999;266(2):149-51.

[35] Qin Bing ZX-Y, Guo Han-Bang. Analysis of Apolipoprotein E Genotype in Parkinson's Disease with or without Dementia.[J]. CHINESE JOURNAL OF NEUROLOGY. 1998;1006-7876(1998,3):3.

[36] Apolipoprotein E genotype in familial Parkinson's disease. The French Parkinson's Disease Genetics Study Group[J]. Journal of neurology, neurosurgery, and psychiatry. 1997;63(3):394-5.

[37] Ballering LA, Steffens-Nakken HM, Esselink RA, et al. Apolipoprotein E genotyping in patients with neurodegenerative diseases[J]. Clinical biochemistry. 1997;30(5):405-11.

[38] Whitehead AS, Bertrandy S, Finnan F, et al. Frequency of the apolipoprotein E epsilon 4 allele in a case-control study of early onset Parkinson's disease[J].

Journal of neurology, neurosurgery, and psychiatry. 1996;61(4):347-51.

[39] Rubinsztein DC, Hanlon CS, Irving RM, et al. Apo E genotypes in multiple sclerosis, Parkinson's disease, schwannomas and late-onset Alzheimer's disease[J].

Molecular and cellular probes. 1994;8(6):519-25.