**Supplementary Table 2. Summary of demographic and clinical characteristics of CTh studies included in the meta-analysis.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  study | Sample sizes (male) | Age, y | Education, y | Duration, y | UPDRS-III | HY stage | MMSE | LEDD(mg) | Quality# |
| **PD** | **HCs** | **PD** | **HCs** | **PD** | **HCs** | **PD** | **HCs** |
| Acosta-Cabronero et al. (2016) | 25 (20) | 50 (28) | 63.6 | 63.6 | NA | NA | 6 | 16.3 | 2.2 | 26.7 | 29.0 | 748 | 9.5 |
| Biundo et al. (2015) | 52 (32)a58 (38)b | 33 (13) | 63.160.3 | 55.3 | 11.310.9 | 11.6 | 8.09.0 | 28.526.7 | 2.32.4 | 2726.4 | 28.2 | 722.6923.1 | 11.511.5 |
| Carriere et al. (2014) | 10 (6)c10 (6)d | 10 (4) | 60.767.2 | 66.8 | 12.510.0 | 10.8 | 11.911.9 | 28.728.1 | NANA | NA&NA& | NA& | 1072.1857.2 | 9.09.0 |
| Carriere et al. (2015) | 17 (13)a19 (15)b | 16 (12) | 57.457.4 | 56 | NANA | NA | 7.26.9 | 19.620.5 | 2.32.4 | 28.928.4 | 28.6 | 817908 | 9.09.0 |
| Cerasa et al. (2013) | 29 (15)e30 (17)f | 24 (13) | 60.162.1 | 63.6 | NANA | NA | 67.3 | 2320 | 2.32.5 | 27.327 | 28 | 520.6534 | 10.510.5 |
| Chung et al. (2019) | 50 (20)g1 | 30 (11) | 69.52 | 70.63 | 8.83 | 10.28 | 2.58 | 25.53 | NA | 26.00 | 28.33 | NA | 10.5 |
| Danti et al. (2015) | 18 (15)h18 (14)g2 | 18 (12) | 60.666.5 | 62.3 | 9.99.7 | 9.6 | 1.51.67 | 10.76.4 | 1.31.6 | 28.726.4 | NA | NA | 10.510.5 |
| Deng et al. (2016) | 67 (37) | 35 (24) | 65.31 | 67.3 | 11.7 | 12.74 | 8.1 | 34.11 | 2.7 | 15.00 | 29.5 | 568.97 | 11.0 |
| Gao et al. (2018) | 28 (17)i32 (12)j | 29 (12) | 57.3261.59 | 59.17 | 10.049.81 | 9.69 | 2.342.54 | 19.2931.08 | 1.51.5 | 28.1427.25 | NA | NANA | 9.09.0 |
| Garcia-Diaz et al. (2014) | 36 (28) | 20 (11) | 64.37 | 69.15 | 12.39 | 11.35 | 10.342 | 17.53 | 2.07 | > 25 | NA | 767.63 | 10.5 |
| Garcia-Diaz et al. (2018) | 92 (37) | 36 (19) | 64 | 63.4 | 10.6 | 11.4 | 8.4 | 16.4 | 1.9 | > 25 | NA | 803.7 | 10.5 |
| Gasca-Salas et al. (2019) | 15 (9)g38 (6)g4 | 18 (11) | 70.169.6 | 67.6 | < 8: 13, ≥ 8: 5< 8: 5, ≥ 8: 3 | < 8: 13, ≥ 8: 5 | 13.312.2 | 17.8 (on)14.6 (on) | 2.92.38 | 26.126.7 | NA | 1198.1961.2 | 9.59.5 |
| Gerrits et al. (2016) | 93 (61) | 45 (27) | 62.8 | 60.6 | **NA\*** | **NA\*** | **3.0** | 25.5 | 2 | 27.7 | 27.8 | 509 | 12 |
| Guimaraes et al. (2016) | 16 (NA)i21 (NA)j11 (NA)k | 40 (NA) | 59.3158.562.07 | 57.60 | 8.057.054.84 | NA | 2.5712.14 | 10.8816.228.35 | 1.252.574.42 | NA$NA$NA$ | NA$ | NA | 10.010.510.0 |
| Huang et al. (2016) | 34 (17) | 45 (24) | 59.25 | 57.0 | NA | NA | 3.95 | 42.3 | 2.5 | 26.15 | NA | NA | 11.5 |
| Ibarretxe-Bilbao (2012) | 16 (NA) | 15 (NA) | 56.13  | 57.58 | 10.96 | 13 | 3.06 | 15.44 | 1.81 | 29.56 | 29.87 | 282.50 | 9.0 |
| Jubault et al. (2011) | 49 (33) | 33 (17) | 63.3 | 65.0 | 14.2 | 14.3 | 4.4 | 28.7 | 1-2.5 | NA@ | NA@ | 411 | 11.0 |
| Kamagata et al. (2017) | 30 (12) | 28 (10) | 67.6 | 66.5 | NA | NA | 6.4 | 16.1 | 2.1 | NA | NA | NA | 11.5 |
| Kunst et al. (2019) | 23 (17)h24 (16)g2 | 58 (18) | 6165.1 | 67.5 | 16.214 | 15.4 | NANA | NANA | NANA | 28.227 | 28.5 | 815.5909 | 11.511.5 |
| Luo et al. (2016) | 56 (28) | 56 (28) | 52.28 | 52.52 | NA | NA | 2.1 | 28.02 | 1.96 | 27.21 | NA | 0 | 11.5 |
| Lyoo et al. (2010) | 48 (22) | 56 (28) | 60.2 | 60.5 | NA | NA | 1.97 | 20.0 | 1.9 | 28.3 | NA | 0 | 11.0 |
| Madhyastha et al. (2015) | 23 (16) | 21 (9) | 63.96 | 61.90 | 16.41 | 15.9 | 6.55 | 22.52 | 2.04 | NA@ | NA@ | NA | 11.5 |
| Mak et al. (2015) | 66 (41)h39 (29)g2 | 37 (21) | 62.969.4 | 65.7 | 13.811.6 | 13.9 | 2.022.08 | 25.329 | 1.92.1 | 29.128.1 | 29.4 | 143.1248.7 | 12.012.0 |
| Nurnberger et al. (2017) | 13 (7) | 18 (9) | 62.6 | 64.4 | NA | NA | 4.5 | 16.8 | 1.2 | NA | NA | NA | 9.0 |
| Pagonabarraga et al. (2013) | 26 (14)h | 18 (10) | 71.5 | 68.2 | 9.0 | 10.4 | 7.3 | 24 | 2.2 | NA& | NA& | 791 | 11.5 |
| Pereira et al. (2012) | 20 (13) | 20 (14) | 64 | 59.1 | NA | NA | 6.8 | 24.9 | 2.4 | 28.5 | 29.8 | 627 | 10.5 |
| Pereira et al. (2019) | 151 (94) | 31 (20) | 60.6 | 58.5 | 15.4 | 16.5 | NA | NA§ | 1.6 | NA@ | NA@ | 0 | 10.5 |
| Rahayel et al. (2019) | 15 (5)l15 (10)m | 41 (25) | 63.166.7 | 63.3 | 15.714.2 | 14.6 | 3.73.9 | 17.624.1 | NANA | NANA | NA | 447.8625.2 | 10.010.0 |
| Tessitore et al. (2016) | 15 (12)a15 (13)b | 24 (17) | 63.1462.87 | 63.54 | 12.99.8 | 10.3 | 6.65.3 | 12.110.9 | 1.41.3 | NANA | NA | 532.1477.3 | 10.010.0 |
| Wilson et al. (2019) | 27 (15)n27 (14)o26 (12)p | 30 (16) | 57.260.760.1 | 60.2 | NANANA | NA | 3.47.213.3 | 20.632.149.1 | 1.72.43.4 | 29.629.629.6 | 29.8 | NANANA | 10.510.510.5 |
| Worker et al. (2014) | 14 (7) | 19 (10) | 64.6 | 63.8 | NA | NA | 6.6 | 21.8 | 2.5 | 29.5 | NA | NA | 9.5 |
| Xiang et al. (2019) | 21 (13)q22 (13)r | 16 (5)20 (10) | 46.5260.82 | 48.0062.65 | 6.767.82 | 8.197.65 | 2.251.83 | 26.7121.09 | 1.711.36 | 27.0526.82 | 27.8826.1 | NANA | 11.511.5 |
| Yadav et al. (2016) | 43 (43)s21 (0)t | 12 (12)34 (34) | 71.269.5 | 73.069.3 | NANA | NANA | 3.673.69 | NANA | NANA | 27.527.8 | 29.029.2 | NANA | 11.011.0 |
| Yao et al. (2014) | 12 (4)u12 (3)v | 14 (6) | 63.467.6 | 64.1 | NANA | NA | 8.410.0 | 18.020.9 | 2.83.2 | 28.527.6 | 29.1 | 704.9978.7 | 9.09.0 |
| Yoo et al. (2015) | 43 (25)w | 23 (NA) | 67.1 | 71 | 9.0 | NA | 3.0 | 26.8 | NA | 28.0 | 28.0 | 530.0 | 10.5 |
| Yoon et al. (2019) | 40 (27)x20 (15)y | 29 (14) | 70.271.3 | 68.7 | 15.414.4 | 16.7 | 5.36.4 | 16.722.0 | NANA | NA@NA@ | NA@ | 730.9910.7 | 10.510.5 |
| Zanigni et al. (2016) | 11 (8) | 22 (12) | 58.0 | 56.4 | 13.0 | NA | 1.9 | 13.0 | 1.55 | 29.0 | NA | NA | 9.5 |
| Zhang et al. (2015) | 71 (40) | 48 (30) | 62.21 | 61.70 | 14.97 | 15.78 | 4.7 | 21.4 | 1.7 | NA | NA | NA | 10 |

CTh, cortical thickness; PD, Parkinson’s disease; HCs, healthy controls; y, years; UPDRS-III, Unified Parkinson’s Disease Rating Scale, part III; HY, Hoehn and Yahr scale; MMSE, mini-mental state examination; LEDD, Levodopa equivalent daily dose; NA, not available; a, Parkinson’s disease patients without impulse control disorders; b, Parkinson’s disease patients with impulse control disorders; c, Parkinson’s disease patients without apathy; d, Parkinson’s disease patients with apathy; e, non-dyskinetic Parkinson’s disease patients; f, dyskinetic Parkinson’s disease patients; g1, Parkinson’s disease patients with non-amnestic mild cognitive impairment; g2, Parkinson’s disease patients with mild cognitive impairment; g3, Parkinson’s disease patients with mild cognitive impairment non-converters; g4, Parkinson’s disease patients with mild cognitive impairment converters; h, Parkinson’s disease patients without mild cognitive impairment; i, mild Parkinson’s disease patients (HY 1–1.5); j, moderate Parkinson’s disease patients (HY 2–2.5); k, severe Parkinson’s disease patients (HY 3–5); l, Parkinson’s disease with rapid eye movement sleep behavior disorder; m, Parkinson’s disease with rapid eye movement sleep behavior disorder; n, mild Parkinson’s disease patients (HY stage 1–2), o, moderate Parkinson’s disease patients (HY 2–3); p, severe Parkinson’s disease patients (HY 3–4); q, early onset Parkinson’s disease; r, late onset Parkinson’s disease; s, male patients with Parkinson’s disease; t, female patients with Parkinson’s disease; u, Parkinson’s disease without visual hallucination; v, Parkinson’s disease with visual hallucination; w, Parkinson’s disease patients without punding behavior; x, Parkinson’s disease without mild behavioral impairment; y, Parkinson’s disease with mild behavioral impairment. &, Mattis Dementia Rating Scale; $, Scales for Outcomes in Parkinson’s Disease-Cognition; @, Montreal Cognitive Assessment; §, MDS-UPDRS-III; \* Education level was determined by using a Dutch education system.