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1. **Supplemental Methods**
2. **Search Strategy**

We conducted a systematic search of the major electronic databases in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. The following search terms and their combinations were used:” psychosis”, “psychotic”, “schizophrenia”, “positive symptoms”, “negative symptoms”, “auditory verbal hallucinations”, “auditory hallucinations”, “hallucinations”, ““transcranial magnetic stimulation”, “TMS”, “repetitive transcranial magnetic stimulation”, “rTMS”, transcranial direct current stimulation”, “tDCS”, The following databases were searched from January 1st 1996 – February 1st 2017: Cochrane Central Register of Controlled Trials, ClinicalTrials.gov, Cochrane Database of Systematic Reviews, Embase Psychiatry, Ovid Medline, PubMed and PsychINFO. All articles were searched for cross references.

| **Supplemental Table S1. Demographic data from the primary studies included in each meta-analysis of tDCS vs sham** | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | AHRS | | Composite Hallucinations | | PANSS Positive | | PANSS Negative | | PANSS Total | |
| Active (n) | 39 | | 80 | | 97 | | 97 | | 86 | |
| Sham (n) | 36 | | 61 | | 93 | | 93 | | 77 | |
| **Active Condition** | | | | | | | | | | |
|  | Mean | Range | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Age (years) | 40.3 | 37-44 | 41.9c | 37-47c | 41.5 | 37-47 | 41.5 | 37-47 | 42.5 | 38-47 |
| Sex (%male) | 70.9a | 70-73 | 74.7a,c | 70-85a,c | 69.7a,c | 50-83a,c | 69.7a,c | 50-83a,c | 68.2 | 50-83 |
| Illness duration (years) | 13.5 | 12-15 | - | - | 11.4 | 7-15a,c,d,e | 11.4 | 7-15a,c,d,e | 11.2 | 7-15 |
| Medication dose (CPZE)  Active tDCS | 508.5 | 23-994 | - | - | 525.2 | 23-994b-e | 525.2 | 23-994b-e | 776.4b-e | 558-994 |
| tDCS cumulative stimulation | 66.6 | 40-80 | 53.6 | 28.4-80 | 46.4 | 28.4-80 | 46.4 | 28.4-80 | 40.87 | 28.4- 80 |
| **Sham Condition** | | | | | | | | | | |
| Age (years) | 37.4 | 35-40 | 39.3c | 35-45c | 37.6 | 34-45 | 37.6 | 34-45 | 37.6 | 34- 45 |
| %male | 65.8a | 58-73 | 64.7a,c | 58-73a,c | 73.8a,c | 58-100a,c | 73.8a,c | 58-100a,c | 77.7 | 62-100 |
| Illness duration (years) | 14.4 | 12-17 | - | - | 14.2 | 12-17a,c-e | 14.2 | 12-17a,c-e | 15.2 | 14-17 |
| Medication dose (CPZE) | 362.7 | 25-1209 | - | - | 571.9 | 25-1209b-e | 571.9 | 25-1209b-e | 845.2,c,d,e | 482-1209 |
|  |  |  |  |  |  |  |  |  |  |  |
| adata not reported in Brunelin 2012; bdata not reported in Frohlich 2016; cdata not reported in Fitzgerald 2014; ddata not reported in Gomes 2015; edata not reported in Smith 2015. Dashes indicate insufficient data for calculation of mean values  AHRS=Auditory Hallucinations Rating Scale, CPZE=Chlorpromazine Equivalence dose (mg), PANSS =Positive and Negative Syndrome Scale, tDCS=Transcranial Direct Current Stimulation | | | | | | | | | | |

1. **Supplemental Results**
2. **Details of Studies Included in the meta-analyses**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Supplemental Table S2. Demographic data from the primary studies included in each meta-analysis of rTMS vs sham** | | | | | | | | | | |
|  | AHRS | | Composite Hallucination Score | | PANSS Positive | | PANSS Negative | | PANSS Total | |
| Active (n) | 263 | | 340 | | 585 | | 496 | | 467 | |
| Sham (n) | 194 | | 238 | | 414 | | 373 | | 350 | |
|  | Mean | Range | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| **Active Condition** | | | | | | | | | | |
| Age | 39.1a,b | 33-46a,b | 38.2c | 30.4-46 | 37.1b,c,d | 30-44b,c | 37.7c, d | 30- 50c,d | 37.5 | 30-41 |
| Sex  (% male) | 57.5a- f | 44 – 73 a- f | 57.1a-f | 44- 73  a- f | 64.9c, d, f, g | 39 – 100  c, d, f, g | 64.9c, d, f, g | 39-100c, d, f, g | 66.2b,f,g | 39-100 b, f, g |
| Medication dose (CPZE) | 516.3  a, b, f, I, j, k, m | 177-811  a, b, f, I, j, k, m | 516.3  a, c, f, I, d, j, k, m, r | 177-811 a, c, f, I, d, j, k, m, r | 444.1  b, c, d, f, g, j, k, m, o, q, r, s, t | 214-1168  b, c, d, f, g, j, k, m, o, q, r, s, t | 478.8  o, g, p, c, k, j, d, q | 216-11680  o, g, p, c, k, j, d, q | 337.8  b, j, n, f, I, g, o | 214-475  b, j, n, f, I, g, o |
| Illness duration (years) | 15.4  a, e, j, k, r, u | 9-23  a, e, j, k, r, u | 16.3  a, c, d, e, k, I, m, r, u, | 9-23  a, c, d, e, k, I, m, r, u, | 10.8  d, j, I, o, p, r, v | 3-23  d, j, I, o, p, r, v | 10.5 | 4-21 | 10.8  d, i, j, o, p, r, v | 3-23  d, i, j, o, p, r, v |
| TMS cumulative stimulation | 8405.3 | 682-90000 | 7960.8 | 639-90000 | 6201.7 | 85-90000 | 6513.7 | 85-90000 | 6790.5 | 85-90000 |
| **Sham Condition** | | | | | | | | | | |
| Age | 38.9a, b | 34-42a, b | 30.4 c | 33-41c | 35.8b, c,d | 30-42 b-d | 38.1 c, d | 30-48 c, d | 37.6 | 30-47 |
| Sex  (% male) | 55.1a-f | 47-78a- f | 53.6a-f | 47-78  a, b, c, d, e, f, | 65.8c, d, f, g | 35-100c, d, f, g | 65.8  c, d, f, g | 35-100  c, d, f, g | 64.8 | 35-100 b, f, g |
| Medication dose (CPZE) | 659.6  a, b, f, I, j, k, m | 355-1030.7  a, b, f, I, j, k, m | 659.6  a, c, f, I, d, j, k, m, r | 355-1031  a, c, f, I, d, j, k, m, r | 584.1  b, c, d, f, g, j, k, m, o, q, r, s, t | 248-1310  b, c, d, f, g, j, k, m, o, q, r, s, t | 563.9  o, g, p, c, k, j, d, q | 248-1310  o, g, p, c, k, j, d, q | 406.9  b, j, n, f, I, g, o | 248–654  b, j, n, f, I, g, o |
| Illness duration (years) | 16.3  a, e, j, k, r, u | 15.08-18.5  a, e, j, k, r, u | 16.4  a, c, d, e, k, I, m, r, u, | 15-19  a, c, d, e, k, I, m, r, u, | 11.5  d, j, I, o, p, r, v | 4-19  d, j, I, o, p, r, v | 12.3 | 5-28 | 10.8  d, i, j, o, p, r, v | 4-19  d, j, o ,p, r, v |
| adata not reported for Poulet 2005; bdata not reported for Klirova 2013; cdata not reported for McIntosh 2004; ddata not reported for Fitzgerald 2005, 2008; edata not reported for Brunelin 2006; fdata not reported for Blumberger 2012; gdata not reported for Saba 2006; hdata not reported in Holi; idata not reported for de Jesus 2010; jdata not reported for Koops 2016; kdata not reported for Lee 2005; mdata not reported in Slotema 2011; ndata not reported for Li 2016; odata not reported for Zhao 2014; pdata not reported for Rabany 2014; qdata not reported for Dlabac de Lange; rdata not reported for Klirova 2013; sdata not reported for Lee 2005; tdata not reported for Hoffman 2005; udata not reported for Hoffman 2013; vdata not reported for Wobruck 2015  AHRS=Auditory Hallucinations Rating Scale, CPZE=Chlorpromazine Equivalent dose (mg), PANSS=Positive and Negative Syndrome Scale, rTMS – Repetitive Transcranial Magnetic Stimulation | | | | | | | | | | |

1. **Efficacy of tDCS vs Sham**

**2.1. tDCS vs sham: Auditory Hallucinations Rating Scale (AHRS) scores**

We compiled data from 3 studies[1–3] that used the Auditory Hallucinations Rating Scale (AHRS) score as the outcome measure. This data set involved 39 patients allocated to the active tDCS condition and 36 patients allocated to the sham condition. Patients in the active treatment group had a mean age of 40.30 years (range 36.7-43.8), were predominantly male (70.98%), had a mean illness duration of 13.59 years (range 11.80-15.38), and received an average daily antipsychotic dose of 508.50mg CPZE (range 23-994). The mean tDCS cumulative stimulation was 66.67 (range 40-80) and the mean tDCS density of administration was 1.67 (range 1-2). Patients in the sham treatment group had a mean age of 37.47 years (range 35.10-40), were predominantly male (65.83%), had a mean illness duration of 14.41 years (range 12.20-16.62), and received an average daily antipsychotic dose of 362.70mg CPZE (range 25.40-1209). Despite a moderate reduction in AHRS scores (Hedge’s g=-0.63) the effect of active treatment was not significant (p=0.23) (supplemental Figure S5). No moderator variables were examined due to insufficient data.

**2.2. tDCS vs sham: Positive Psychotic Symptoms**

We analysed data from 7 tDCS studies[1,3–8] based on the PANSS positive symptoms subscale derived from 97 patients allocated to active tDCS and 93 patients allocated to the sham condition. Patients allocated to active tDCS had a mean age of 41.56 years (range 36.70-46.76), were mostly male (69.75% male), had a mean illness duration of 11.43 years (range 7.10-15.38) and received an average daily antipsychotic dose of 525.27mg CPZE (range 23-994). The mean tDCS cumulative stimulation was 46.46 (range 28-80) and the mean tDCS density of administration was 1.16 (range 0.71-2). Patients allocated to the sham condition had a mean age of 37.61 years (range 34.10-44.88), were mostly male (73.83%), had a mean illness duration of 14.21 years (range 12.20-16.62) and received an average daily antipsychotic dose of 571.97mg CPZE (range 25.40-1209). Hedge’s g effect size was -0.10 which did not reach statistical significance (p=0.59). The I2 statistic for this analysis was 42.31%. Details of the moderator analyses are shown in Supplementary Table S3. We found no significant effect of age, sex, tDCS cumulative stimulation or tDCS density of administration (p>0.40). Moderator analysis of illness duration and antipsychotic dose were not calculated due to insufficient data.

**2.3. tDCS vs sham: Negative Symptoms**

We analyzed data from the PANSS negative symptoms subscale score from the same 7 studies[1,3–8] considered above. There was a significant effect of treatment (Hedge’s g=-0.63, p=0.02) and evidence of significant heterogeneity (I2= 69.70%). Details of the moderator analyses are shown in Supplementary Table S3. We only found a significant effect of age in the sham treatment group (coefficient=0.16, p=0.005). The effect of illness duration and antipsychotic dose were not calculated due to insufficient data.

**2.4. tDCS vs sham: Overall Symptom Severity**

We included 6 studies[1,3–5,7,8] that provided data on the PANSS total score from 86 patients allocated to active tDCS and 77 patients allocated to sham treatment. Patients allocated to the active tDCS group had a mean age of 42.53 years (range 38.4-46.76), were predominantly male (68.245%), had a mean illness duration of 11.24 years (range 7.10-15.38 years), and received a mean daily antipsychotic dose of 776.4mg CPZE (range 558-994). The mean tDCS cumulative stimulation was 40.87 (range 28.4-80) and the mean tDCS density of administration was 1.02 (range 0.71-2). Patients allocated to the sham group had a mean age of 37.67 years (range 34.1-44.88), were predominantly male (77.71%), had a mean illness duration of 15.21 years (range 13.8-16.62), and received a mean daily antipsychotic dose of 845.25mg CPZE (range 481.50-1209). There was no significant symptom reduction with active treatment (Hedge’s g= -0.48, p=0.12). I2 statistic for heterogeneity was 72.95%. Moderator analyses of illness duration and mean medication dosage were not performed due to insufficient primary data. All other moderator analyses were not significant as detailed in Supplemental Table S3.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Supplemental Table S3. Effect of moderator variables in tDCS vs Sham** | | | | | | | | | | | |
| **Moderator**  **Variable** | **Coefficient** | **SE** | **95% CI** | **Z-value** | **P-value** | **df** | **Qmodel** | **Tau2** | **I2** | **I2-p value** | **Adjusted R** |
| **Composite Hallucinations Score** | | | | | | | | | | | |
| Age-tDCS | 0.13 | 0.10 | 0.07 to 0.34 | 1.28 | 0.20 | 1 | 1.64 | 0.50 | 77.87 | 0.001 | 0.24 |
| Age-Sham | 0.17 | 0.08 | 0.01 to 0.33 | 2.19 | 0.02 | 1 | 4.78 | 0.21 | 59.36 | 0.08 | 0.67 |
| **Density of administration** | **-1.04** | **0.41** | **1.85 to 0.23** | **2.54** | **0.01** | **1** | **6.43** | **0.12** | **49.14** | **0.11** | **0.71** |
| **Cumulative Stimulation** | **-0.02** | **0.01** | **0.04 to 0.005** | **2.53** | **0.01** | **1** | **6.38** | **0.12** | **49.45** | **0.11** | **0.71** |
| **Positive and Negative Syndrome Scale: Positive Symptoms Score** | | | | | | | | | | | |
| Age-tDCS | 0.05 | 0.06 | -0.07 to 0.18 | 0.86 | 0.39 | 1 | 0.74 | 0.14 | 47.09 | 0.10 | 0 |
| Age-Sham | 0.012 | 0.06 | -0.10 to 0.13 | 0.19 | 0.84 | 1 | 0.04 | 0.19 | 53.3 | 0.07 | 0 |
| Sex-tDCS | 0.006 | 0.02 | -0.04 to 0.05 | 0.23 | 0.81 | 1 | 0.05 | 0.24 | 62.09 | 0.07 | 0 |
| Sex-Sham | -0.004 | 0.01 | -0.04 to 0.03 | -0.23 | 0.82 | 1 | 0.05 | 0.23 | 62.2 | 0.07 | 0 |
| Density of administration | -0.46 | 0.31 | -1.08 to 0.15 | -1.48 | 0.13 | 1 | 2.19 | 0.05 | 29.10 | 0.21 | 0.43 |
| Cumulative Stimulation | -0.01 | 0.007 | -0.02 to 0.003 | -1.48 | 0.13 | 1 | 2.19 | 0.05 | 29.13 | 0.21 | 0.43 |
| **Positive and Negative Syndrome Scale: Negative Symptoms Score** | | | | | | | | | | | |
| Age-tDCS | 0.12 | 0.08 | -0.04 to 0.29 | 1.45 | 0.14 | 1 | 2.10 | 0.36 | 65.96 | 0.01 | 0.30 |
| **Age-Sham** | **0.16** | **0.05** | **0.04 to 0.27** | **2.77** | **0.005** | **1** | **7.66** | **0.52** | **41.83** | **0.14** | **0.74** |
| Sex-tDCS | 0.05 | 0.03 | -0.01 to 0.11 | 1.58 | 0.11 | 1 | 2.49 | 0.38 | 71.46 | 0.03 | 0.30 |
| Sex-Sham | -0.03 | 0.02 | -0.08 to 0.01 | -1.21 | 0.22 | 1 | 1.46 | 0.51 | 78.19 | 0.01 | 0.06 |
| Density of administration | -0.02 | 0.55 | -1.10 to1.06 | -0.04 | 0.96 | 1 | 0.00 | 0.45 | 73.84 | 0.001 | 0 |
| Cumulative Stimulation | -0.0005 | 0.01 | -0.02 to 0.02 | -0.03 | 0.97 | 1 | 0.00 | 0.45 | 73.82 | 0.001 | 0 |
| **Positive and Negative Syndrome Scale: Total Score** | | | | | | | | | | | |
| Age-tDCS | 0.13 | 0.12 | -0.11 to 0.38 | 1.08 | 0.28 | 1 | 3.57 | 0.33 | 76.99 | 0.001 | 0.11 |
| Age-Sham | 0.11 | 0.08 | -0.04 to 0.28 | 1.4 | 0.16 | 1 | 1.95 | 0.47 | 71.17 | 0.01 | 0.11 |
| Sex-tDCS | 0.028 | 0.048 | -0.06 to 0.12 | 0.58 | 0.56 | 1 | 0.33 | 1.07 | 83.35 | 0.002 | 0 |
| Sex-Sham | -0.0304 | 0.038 | -0.10 to 0.04 | -0.81 | 0.41 | 1 | 0.65 | 0.88 | 81.01 | 0.005 | 0 |
| Density of administration | -0.004 | 0.01 | -0.04 to 0.03 | -0.26 | 0.79 | 1 | 0.07 | 0.49 | 75.93 | 0.002 | 0 |
| Cumulative Stimulation | -0.19 | 0.72 | -1.6 to 1.22 | -0.27 | 0.78 | 1 | 0.07 | 0.49 | 75.90 | 0.002 | 0 |

1. **Efficacy of rTMS vs Sham**

**3.1. rTMS vs sham: Auditory Hallucinations Rating Scale (AHRS) scores**

We analysed 12 studies[9–20] reporting data on the AHRS from 307 patients receiving active rTMS and 206 patients receiving sham treatment. Patients allocated to active rTMS had a mean age of 39.12 years (range 33.83-46), mean duration of illness of 15.42 years (range 9.1-22.2), and received a mean daily antipsychotic dose of 516.37mg CPZE (range 176.8-810.8). Patients allocated to the sham condition had a mean age was 38.93 years (range 34-42), mean duration of illness of 16.37 years (range 15.08-18.5), and received a mean daily antipsychotic dose of 659.6mg (range 355-1030.7). There was a moderate over-representation of males in both the active rTMS (57.52%) and sham (55.09%) treatment groups. The mean rTMS density of administration was 1.16 (range 0.71-2) and mean rTMS cumulative stimulation was 8405.385 (range 681.6-90000). Active treatment was associated with significant symptom reduction (Hedge’s g=–0.54, p=0.0003) and the I2 statistic (63.39%) indicated moderate heterogeneity (supplemental Figure S6). Details of the moderator analyses are shown in Supplemental Table 4. We found effect of age in the sham groups (coefficient=0.14, p=0.0001) but not sex (p>0.70). In the active rTMS condition there was a statistically significant effect of antipsychotic dose (coefficient=0.003, p=0.03) but not of cumulative stimulation or density of administration (p>0.25). We did not examine the effect of illness duration and cumulative rTMS stimulation due to insufficient primary data.

**3.2. rTMS vs sham: Composite Hallucinations Score**

We analyzed data from 14 studies[9–22] on the composite hallucinations score derived from 340 patients allocated to active rTMS and 238 patients allocated to the sham condition. Patients in the active rTMS condition had a mean of 38.26 years (range 30.4-46), mean illness duration of 16.39 years (range 9.1-22.2), and received an average daily antipsychotic dose of 516.37mg CPZE (range 176.8-810.8). Patients in the sham condition had a mean age of 38.03 years (range 33.2-41), mean illness duration of 16.50 years (range 15.08-19), and received an average daily antipsychotic dose of 659.6mg CPZE (range 355-1030.7). There was a moderate over-representation of males in both the active rTMS (57.14%) and sham (53.63%) treatment groups. The mean rTMS cumulative stimulation was 7960.87 (639-90000) and the mean rTMS density of administration was 1.04 (0.71-2). There was a significant effect of rTMS treatment (Hedge’s g=-0.51, p=0.00016) and moderate heterogeneity (I2=58.81%). Details of the moderator analyses are shown in supplemental Table S4. There was no effect of sex, illness duration density of administration or cumulative stimulation (p>0.12), There was a small but significant effect of age in the treatment (coefficient 0.08, p=0.03) and sham groups (coefficient=-0.001, p<0.0001). Higher antipsychotic dose was associated with diminished effect of active treatment (coefficient=0.003, p=0.03).

**3.3. rTMS vs Sham: Positive Psychotic Symptoms**

We analyzed data from 22 studies[9,12,15–17,19,20,22–36] reporting PANSS positive symptoms subscale scores from 585 patients undergoing active rTMS treatment and 414 patients allocated to sham treatment. Patients in the active rTMS group had a mean age of 37.05 years (range 30.2-43.8), mean illness duration of 10.80 years (range 3.81-22.2), and received a mean daily antipsychotic dose of 444.1786mg CPZE (range 214.16-1168). Patients in the sham condition had a mean age 35.81 years (range 29.5-42), mean illness duration of 11.53 years (range 4.13-19), and received a mean daily antipsychotic dose of 584.14mg CPZE (range 247.73-1309). There was an over-representation of males in both active rTMS (64.92%) and the sham (65.85%) sham treatment group. The mean rTMS cumulative stimulation was 6201.70 (range 85.2-90000) and the mean rTMS density of administration was 0.88 (range 0.04-2). There no significant effect of treatment (Hedge’s g= 0.29, p=0.14). The I2 statistic for this analysis was 87.88% suggesting considerable heterogeneity. We found small but significant effect of age in the active (coefficient=0.20, p<0.0001) and in the sham condition (coefficient=0.11, p=0.006). The effect of all other moderator variables was not significant (p>0.08). Moderator effects of illness duration were not examined due to insufficient primary data. Of the 22 studies, 10 studies[23,24,26,28–32,35,36] targeted the dorsolateral prefrontal cortex. In this subset, a significant effect of treatment was observed (Hedges g=1.003, p=0.008). Eleven studies[9,12,15–17,19,20,22,25,33,34] targeted the left temporoparietal junction. In this subset, no significant effect of treatment was found (Hedge’s g=-0.14, P>0.38. One study targeted the cerebellum[27].

**3.4. rTMS vs sham: Negative Symptoms**

We analyzed data from 19 studies[16,17,20,22–37] reporting on changes in the PANSS negative symptoms subscale score from 496 patients undergoing active rTMS and 373 patients undergoing sham treatment. Patients in the active rTMS group had a mean age of 37.76 years (range 29.83-49.1), mean illness duration of 10.52 years (range 4.91-20.53), and received a mean daily antipsychotic dose of 478.89mg CPZE (range 216.92-1168). Patients in the sham treatment group had a mean age of 38.11 years (range 29.5-47.92), mean illness duration of 12.35 years (range 5.89-27.3), and received a mean daily antipsychotic dose of 563.917mg CPZE (range 247.73-1309). There was an over-representation of males in both active rTMS (64.92%) and sham (65.85%) treatment groups. The mean rTMS cumulative stimulation was 6513.78 (range 85.2-90000) and mean rTMS density of administration 0.89 (range 0.47-2). There was a significant effect of treatment (Hedges g=-0.49, p=0.01) with evidence of considerable heterogeneity (I2=86.60%). Older age was associated with greater improvement in symptoms both in active (coefficient=-0.09, p=0.001) and sham (coefficient=-0.09, p=0.004) treatment groups while male sex was associated with a small reduction in active treatment efficacy (coefficient=0.03, p=0.03). No other moderate effect was significant (p>0.06). Moderator analyses for illness duration were not performed due to insufficient data. We were able to examine the effect of target location in 18 studies; 11 [23,24,26,28–32,35–37] targeted the dorsolateral prefrontal cortex and 7[16,17,20,22,25,33,34] targeted the left temporoparietal junction. Targeting the prefrontal cortex was associated with significant reduction in negative symptoms (Hedge’s g=-0.73, p=0.014) while targeting the temporoparietal junction had no effect (Hedge’s g=-0.07, p=0.67).

**3.5. rTMS vs sham: Overall Symptom Severity**

We analyzed data from 18 studies[9,11,15,16,25,27–39], reporting PANSS total scores derived from 467 patients receiving active rTMS and 350 patients receiving sham treatment. Patients in the active rTMS group had a mean age of 37.58 years (range 30.2 – 40.87), a mean illness duration of 10.81 years (range 3.81 – 22.2), and received a mean daily antipsychotic dose of 337.89mg CPZE (range 214.16-475). Patients in the sham treatment group had a mean age of 37.66 years (range 29.5-46.87), a mean illness duration of 10.83 years (range 4.13-19), and received a mean daily antipsychotic dose of 406.91mg CPZE (range 247.73-653.30). There was an over-representation of males in the active rTMS (66.23%) and sham (64.87%). The mean rTMS cumulative stimulation was 6790.58 (range 85.2-90000) and mean rTMS density of administration was 0.80 (range 0.47-2). There was no significant effect of treatment (Hedge’s g=-0.29, p=0.06) and the level of heterogeneity was high (I2= 78.63%). Details of the moderator analyses are shown in supplemental table S4. Older age was associated with marginally greater symptoms reduction in the sham group (coefficient=-0.06, p=0.02) but no other moderator effects were significant (p>0.07). Moderator analysis for illness duration was not performed due to insufficient primary data. Eleven studies[26,28–32,35–38] targeted the dorsolateral prefrontal cortex and 6 studies targeted the temporoparietal junction[9,11,15,16,33,34]. Total symptoms severity showed a significant increase in the former (Hedge’s g= 0.05, p=0.03) but not the latter (Hedge’s g=-0.12, P=0.33).

| **Supplemental Table S4. Moderator analyses of studies using rTMS vs Sham** | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Moderator**  **Variable** | **Coefficient** | **SE** | **95% CI** | **Z-value** | **P-value** | **df** | **Qmodel** | **Tau2** | **I2** | **I2-p value** | **Adjusted R2** | |
| **Auditory Hallucinations Rating Scale** | | | | | | | | | | | | |
| **Age-rTMS** | **0.08** | **0.04** | **-0.01 to 0.16** | **2.21** | **0.02** | **1** | **4.9** | **0.13** | **53.10** | **0.015** | | **0.37** |
| **Age-Sham** | **0.14** | **0.03** | **0.07 to 0.20** | **4.05** | **0.0001** | **1** | **16.36** | **0.018** | **13.42** | **0.31** | | **0.91** |
| Sex-rTMS | 0.008 | 0.021 | -0.03 to 0.05 | 0.38 | 0.70 | 1 | 0.14 | 0.26 | 69.65 | 0.01 | | 0 |
| **Antipsychotic dose-rTMS** | **0.003** | **0.015** | **0.0003 to 0.06** | **2.16** | **0.03** | **1** | **4.65** | **0.21** | **66.68** | **0.745** | | **1** |
| Antipsychotic dose-Sham | 0.001 | 0.001 | -0.0004 to 0.003 | 1.54 | 0.12 | 1 | 2.36 | 0.026 | 16.08 | 0.30 | | 0.76 |
| Cumulative Stimulation | 0.006 | 0.006 | -0.005 to 0.002 | 1.15 | 0.25 | 1 | 1.32 | 0.21 | 60.07 | 0.0014 | | 0.06 |
| **Composite Hallucination Score** | | | | | | | | | | | | |
| **Age-rTMS** | **0.082** | **0.038** | **0.007 to 0.15** | **2.15** | **0.03** | **1** | **4.63** | **0.12** | **51.89** | **0.01** | | **0.37** |
| **Age-Sham** | **0.14** | **0.03** | **0.07 to 0.20** | **4.18** | **<0.0001** | **1** | **17.50** | **0.01** | **8.42** | **0.36** | | **0.94** |
| Sex-rTMS | 0.006 | 0.02 | -0.03 to 0.04 | 0.32 | 0.75 | 1 | 0.10 | 0.25 | 68.61 | 0.001 | | 0 |
| Sex-Sham | 0.001 | 0.02 | -0.043 to 0.045 | 0.05 | 0.96 | 1 | <0.01 | 0.24 | 68.73 | 0.001 | | 0 |
| Duration of Illness-rTMS | 0.01 | 0.03 | -0.057 to 0.09 | 0.47 | 0.64 | 1 | 0.22 | 0.073 | 36.57 | 0.18 | | 0 |
| Duration of Illness- Sham | 0.032 | 0.06 | -0.09 to 0.16 | 0.49 | 0.62 | 1 | 0.24 | 0.074 | 35.45 | 0.19 | | 0 |
| **Antipsychotic Dose-rTMS** | **0.003** | **0.001** | **-0.0002 to 0.006** | **2.11** | **0.03** | **1** | **4.74** | **<0.01** | **36.66** | **0.88** | | **1.00** |
| Antipsychotic Dose-Sham | 0.001 | 0.001 | -0.0007 to 0.0031 | 1.24 | 0.22 | 1 | 1.54 | 0.04 | 23.63 | 0.27 | | 0.50 |
| Cumulative Stimulation | 0.006 | 0.005 | -0.004 to 0.01 | 1.17 | 0.24 | 1 | 1.38 | 0.17 | 55.17 | 0.003 | | 0.07 |
| **Positive and Negative Syndrome Scale: Positive Symptoms Score** | | | | | | | | | | | | |
| **Age-rTMS** | **0.20** | **0.03** | **0.12 to 0.27** | **5.43** | **<0.0001** | **1** | **29.48** | **0.88** | **88.90** | **<0.01** | **0.03** | |
| **Age-Sham** | **0.11** | **0.04** | **0.03 to 0.18** | **2.75** | **0.006** | **1** | **7.55** | **0.98** | **89.89** | **<0.01** | **0** | |
| Sex-rTMS | -0.02 | 0.01 | -0.05 to 0.004 | -1.7 | 0.08 | 1 | 2.88 | 1.09 | 91.52 | <0.01 | 0 | |
| Sex-Sham | -0.009 | 0.01 | -0.04 to 0.02 | -0.62 | 0.53 | 1 | 0.39 | 1.07 | 91.53 | <0.01 | 0 | |
| Antipsychotic Dose-rTMS | 0.0003 | 0.0004 | -0.0006 to 0.001 | 0.65 | 0.51 | 1 | 0.43 | 0 | 0.00 | 0.46 | 0 | |
| Antipsychotic Dose-Sham | 0.0002 | 0.0004 | -0.0006 to 0.001 | 0.51 | 0.61 | 1 | 0.26 | 0 | 0.00 | 0.44 | 0 | |
| Cumulative Stimulation | -0.0009 | 0.0088 | -0.181 to 0.0162 | -0.11 | 0.92 | 1 | 0.01 | 0.52 | 82.19 | <0.01 | 0 | |
| **Positive and Negative Syndrome Scale: Negative Symptoms Score** | | | | | | | | | | | | |
| **Age-rTMS** | **-0.09** | **0.02** | **-0.14 to -0.03** | **-3.17** | **0.001** | **1** | **10.03** | **0.61** | **84.67** | **<0.01** | **0.21** | |
| **Age-Sham** | **-0.09** | **0.03** | **-0.16 to -0.03** | **-2.86** | **0.004** | **1** | **8.15** | **0.69** | **85.94** | **<0.01** | **0.12** | |
| **Sex-rTMS** | **0.03** | **0.01** | **0.002 to 0.05** | **2.1** | **0.03** | **1** | **4.42** | **0.82** | **88.82** | **<0.01** | **0.05** | |
| Sex-Sham | 0.01 | 0.01 | -0.01 to 0.04 | 1.25 | 0.21 | 1 | 1.55 | 0.89 | 89.83 | <0.01 | 0.00 | |
| Antipsychotic Dose-rTMS | 0.0008 | 0.0006 | -0.0003 to 0.001 | 1.38 | 0.16 | 1 | 1.92 | 0.08 | 46.45 | 0.06 | 0.16 | |
| Antipsychotic Dose-Sham | 0.0009 | 0.0005 | -0.0001 to 0.001 | 1.82 | 0.06 | 1 | 3.30 | 0.006 | 41.64 | 0.08 | 0.31 | |
| Density of administration | 0.16 | 0.60 | -1.02 to 1.35 | 0.28 | 0.78 | 1 | 0.08 | 0.80 | 87.18 | <0.01 | 0 | |
| Cumulative Stimulation | -0.0008 | 0.01 | -0.02 to 0.01 | -0.07 | 0.94 | 1 | 0.01 | 0.73 | 86.05 | <0.01 | 0 | |
| **Positive and Negative Syndrome Scale: Total Score** | | | | | | | | | | | | |
| Age-rTMS | -0.04 | 0.02 | -0.08 to 0.004 | -1.76 | 0.07 | 1 | 3.10 | 0.37 | 78.27 | <0.01 | 0.10 | |
| **Age-Sham** | **-0.06** | **0.02** | **-0.11 to -0.01** | **-2.32** | **0.02** | **1** | **5.39** | **0.34** | **76.84** | **<0.01** | **0.15** | |
| Sex-rTMS | 0.009 | 0.01 | -0.02 to 0.03 | 0.75 | 0.45 | 1 | 0.56 | 0.50 | 84.44 | <0.01 | 0.00 | |
| Sex-Sham | 0.002 | 0.01 | -0.02 to 0.02 | 0.02 | 0.98 | 1 | 0.08 | 0.46 | 85.28 | <0.01 | 0.00 | |
| Antipsychotic Dose-rTMS | 0.001 | 0.0007 | -0.0001 to 0.003 | 1.81 | 0.07 | 1 | 3.29 | 0.20 | 70.70 | 0.002 | 0.20 | |
| Antipsychotic Dose-Sham | 0.001 | 0.0007 | -0.0004 to 0.002 | 1.42 | 0.16 | 1 | 2.01 | 0.23 | 73.65 | 0.001 | 0.07 | |
| Density of administration | -0.32 | 0.52 | -1.35 to 0.71 | -0.61 | 0.54 | 1 | 0.37 | 0.40 | 79.06 | <0.01 | 0 | |
| Cumulative Stimulation | -0.008 | 0.01 | -0.03 to 0.01 | -0.77 | 0.44 | 1 | 0.60 | 0.83 | 88.26 | <0.01 | 0 | |

| **Supplemental Table S5: Subgroup Analysis for rTMS studies** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Composite Hallucinations Score\*** | | | | | | |
| **Subgroup** | **Number of studies** | | | **Effect size** | **95% confidence interval** | **P** |
| **Target** | | | | | | |
| Bilateral | 1 | | | -1.24 | -1.73 to -0.75 | **0.006** |
| Left | 12 | | | -0.43 | -0.70 to -0.15 | **0.002** |
| Right | 1 | | | -0.39 | -1.46 to 0.67 | 0.47 |
| **Pulse Frequency** | | | | | | |
| <10Hz | 12 | | | -0.57 | -0.85 to -0.29 | **0.00006** |
| 20-50Hz | 2 | | | -0.14 | -0.84 to 0.56 | 0.69 |
| **Trial Duration** | | | | | | |
| ≤3 weeks | 10 | | | -6.03 | -0.95 to -0.26 | **0.001** |
| >3 weeks | 4 | | | -0.36 | -0.82 to 0.09 | 0.11 |
| **PANSS Positive Scores** | | | | | | |
| **Subgroup** | **Number of studies** | | | **Effect size** | **95% confidence interval** | **P** |
| **Target-Laterality** | | | | | | |
| Bilateral | 3 | | | 0.22 | -0.96 to 1.39 | 0.72 |
| Left | 17 | | | 0.32 | -0.12 to 0.75 | 0.16 |
| Right | 1 | | | 0.27 | -1.73 to 2.27 | 0.79 |
| **Pulse Frequency** | | | | | | |
| <10Hz | 13 | | | -0.11 | -0.3 to 0.08 | 0.25 |
| 10 Hz | 8 | | | -0.01 | -0.2 to 0.17 0.90 | 0.90 |
| 20-50Hz | 3 | | | 0.64 | 0.27 to 1.02 | **0.0008** |
| **Target- Region** | | | | | | |
| PFC | 10 | | | 0.84 | 0.25 to 1.43 | **0.006** |
| TPJ | 11 | | | -0.146 | -0.68 to 0.39 | 0.59 |
| Cerebellar | 1 | | | 0.31 | -0.30 to 0.91 | 0.32 |
| **Motor Threshold Intensity** | | | | | | |
| 110% | 7 | | | 1.13 | 0.44 to 1.81 | **0.001** |
| Other | 16 | | | 0.24 | -0.56 to 0.37 | 0.70 |
| **Trial Duration** | | | | | | |
| ≤3 weeks | 12 | | | -0.14 | -0.69 to 0.41 | 0.62 |
| >3 weeks | 10 | | | 0.70 | 0.17 to 1.24 | **0.01** |
| **PANSS Negative Scores** | | | | | | | |
| **Subgroup** | **Number of studies** | | **Effect size** | | **95% confidence interval** | **P** | |
| **Target-Laterality** | | | | | | | |
| Bilateral | | 3 | -0.07 | | -1.18 to 1.05 | 0.90 | |
| Left | | 14 | -0.70 | | -1.18 to -0.21 | **0.004** | |
| Right | | 1 | 0.34 | | -1.55 to 2.23 | 0.72 | |
| **Pulse Frequency** | | | | | | | |
| <10Hz | | 8 | -0.08 | | -0.77 to 0.61 | 0.82 | |
| 10 Hz | | 8 | -0.62 | | -1.28 to 0.04 | 0.06 | |
| 20-50Hz | | 4 | -0.93 | | -1.76 to -0.09 | **0.03** | |
| **Target-Location** | | | | | | | |
| PFC | | 11 | -0.72 | | -1.24 to -0.2 | **0.007** | |
| TPJ | | 7 | -0.20 | | -0.94 to 0.54 | 0.62 | |
| Cerebellar | | 1 | 0.37 | | -0.24 to 0.98 | 0.69 | |
| **Motor Threshold Intensity** | | | | | | | |
| 110% | | 7 | -1.07 | | -1.67 to -0.46 | **0.0005** | |
| Other | | 12 | -0.06 | | -0.59 to 0.48 | 0.84 | |
| **Trial Duration** | | | | | | | |
| ≤3 weeks | | 10 | -0.03 | | -0.61 to 0.56 | 0.93 | |
| >3 weeks | | 9 | -0.90 | | -1.44 to -0.36 | **0.001** | |
| **PANSS Total Scores** | | | | | | | |
| **Subgroup** | | **Number of studies** | **Effect size** | | **95% confidence interval** | **P** | |
| **Target-Laterality** | | | | | | | |
| Bilateral | | 1 | 0.68 | | -0.2 to 1.57 | 0.13 | |
| Left | | 15 | -0.43 | | -0.75 to -0.10 | **0.01** | |
| Right | | 1 | 0.29 | | -1.07 to 1.65 | 0.67 | |
| **Pulse Frequency** | | | | | | | |
| <10Hz | | 8 | 0.11 | | -0.32 to 0.54 | 0.61 | |
| 10 Hz | | 8 | -0.35 | | -0.78 to 0.009 | 0.12 | |
| 20-50Hz | | 3 | -0.97 | | -1.58 to -0.36 | **0.002** | |
| **Target Location** | | | | | | | |
| PFC | | 10 | -0.50 | | -0.90 to -0.10 | **0.02** | |
| TPJ | | 7 | -0.28 | | -0.60 to 0.43 | 0.75 | |
| Cerebellar | | 1 | 0.65 | | -0.72 to 2.01 | 0.35 | |
| **Motor Threshold** **Intensity** | | | | | | | |
| 110% | | 8 | -0.53 | | -0.97 to -0.09 | **0.02** | |
| Other | | 10 | -0.06 | | -0.49 to 0.37 | 0.78 | |
| **Trial Duration** | | | | | | | |
| ≤3 weeks | | 8 | 0.07 | | -0.44 to 0.57 | 0.79 | |
| >3 weeks | | 10 | -0.50 | | -0.88 to -0.11 | **0.01** | |
| \*All studies targeted the TPJ and used motor threshold of 110%; PFC = Prefrontal Cortex; PANSS=Positive and Negative Syndrome Scale; rTMS – repetitive transcranial magnetic stimulation; TPJ – Temporal-Parietal Junction, | | | | | | | |

1. **Safety and Tolerability**

Details of reported adverse effects and dropouts from each tDCS study are summarized in supplemental Table S5 and corresponding data for each rTMS study are shown in supplemental Table S6. The procedure was well tolerated across all studies for both tDCS and rTMS and none of the reported adverse effects required more than minor medical attention. No persisting adverse effects were reported for either treatment modality.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Supplemental Table S6. Dropouts and adverse effects reported in studies comparing active tDCS to sham** | | | | |
| **Study / Author comments** | **Side effects** | | **Dropouts** | |
|  | Treatment | Sham | Treatment | Sham |
| [4]Fitzgerald 2014 | Itchiness under the electrodes=6  Headache=1 | Itchiness under the electrodes=4  Headache=1  Non-specific site discomfort=2 | None reported | |
| [1]Frohlich 2016 | Mild tingling, itching, and burning; no number reported | | Withdrawal of consent prior to allocation=1 | |
| [5]Gomes 2015 | No adverse effects reported | | None reported | Reason unspecified=1 |
| [6]Mondino 2016 | No adverse effects reported | | No dropouts reported | |
| [8]Palm 2016\* | Mild tingling and transient headache; numbers not reported | | Reason unspecified=1 | Reason unspecified=1 |
| [7]Smith 2015 | Itching, headache, dizziness, or pressure on head; numbers not reported | | No dropouts reported | |
| tDCS=Transcranial Direct Current Stimulation; \* Dropouts not included in analysis | | | | |

| **Supplemental Table S7. Dropouts and adverse effects reported in studies comparing active rTMS to sham** | | | | |
| --- | --- | --- | --- | --- |
| **Study**  **First Author, Year** | **Side effects** | | **Dropouts** | |
|  | Treatment | Sham | Treatment | Sham |
| [23]Barr 2012 | None reported | Intolerance to procedure=1 | Unreliable attendance=5 (allocation unspecified)  Intolerance to procedure=1 (sham group) | |
| [9]Blumberger 2012 | Jaw and facial contraction=4  Headaches=6 | None reported | Unreliable attendance=5 | Unreliable attendance=2 |
| [10]Brunelin 2006 | None reported | | No dropouts reported | |
| [24]Dlabac-de Lange 2015 | Twitching of the facial muscles during stimulation and headache after; numbers not reported | | None reported in either group | |
| [11]de Jesus 2011 | Headache=2 |  | None reported in either group | |
| [25]Fitzgerald 2005 | None reported | Deterioration of mental state=2 | Withdrawal of consent prior to starting treatment=1 | Deterioration of mental state=2 |
| [26]Fitzgerald 2008 | Site discomfort=4 | Site discomfort=1  Headache=1 | Withdrawal of consent=2 | Withdrawal of consent=3 |
| [27]Garg 2016 | Headache=5  Excessive sleepiness=1 |  | Infective febrile illness=1  Extrapyramidal syndrome=1  Diagnosis revised to schizoaffective disorder=2  Discharged from service=3 | |
| [12]Hoffman 2005\* | Headache, lightheadedness, concentration complaints; numbers not reported | | Deterioration in cognitive tests=1  lightheadedness =1 | Deterioration in cognitive tests=2 |
| [13]Hoffman 2013 | Pain=1  Malingering=1 | None reported | Reasons unspecified=5 | None reported |
| [28]Holi 2004 | Paranoia=1 | Paranoia=1 | Paranoia=1 | Paranoia=1 |
| [14]Kimura 2016 | None reported | None reported | None reported | None reported |
| [15]Klirova 2013 | None reported | None reported | Symptoms resolved after first session=1  Unreliable attendance=1  Medication changes between crossover arms=3 | |
| [29]Klein 1999\* | Facial muscle twitches=3  Headache=2  Worsening of preexisting akathisia=2  Worsening of preexisting obsessive compulsive  symptoms=2 | None reported | Reasons unspecified=2 | Reasons unspecified=2 |
| [16]Koops 2016\* | Agitation=7  Speech disorder= 5  Amblyopia=2  Anxiety=8  Apathy=4  Ataxia=3  Confusion=10  Convulsions=1  Pain=17  Euphoria=5  Incoordination=2  Insomnia=4  Malaise=5  Dizziness=14  Myoclonus=4  Nausea=9  Nervousness=6  Palpitations=3  Paresthesia=3  Syncope=2  Twitching=4  Vertigo=4  Blurred vision=5  Vomiting=3 | Agitation =5  Speech disorder =1  Amblyopia=1  Anxiety=10  Apathy=8  Ataxia=1  Confusion=7  Convulsions n=0  Pain=15  Euphoria=5  Incoordination=1  Insomnia=6  Malaise=5  Dizziness=9  Myoclonus=6  Nausea=6  Nervousness=12  Palpitation=2  Paresthesia=6  Syncope =0  Twitching=8  Vertigo =3  Blurred vision=1  Vomiting=0 | Reasons unspecified=5 | Reasons unspecified=2 |
| [17]Lee 2005 | Headache=5  Dizziness=2  Amnesia=1 | Headache=2  Dizziness=1  Difficulty concentrating=1 | No dropouts reported | No dropouts reported |
| [38]Li 2016 | None reported | None reported | Consent withdrawn prior to study=3  Premature discharge=2 | Consent withdrawn prior to study=3  Premature discharge=1 |
| [22]McIntosh 2004 | Headache; numbers not reported | | No dropouts reported | No dropouts reported |
| [18]Poulet 2005 | None reported | Headache=1 | No dropouts reported | No dropouts reported |
| [30]Prikryl 2007 | Headache=2; Allocation unspecified | | No dropouts reported | No dropouts reported |
| [39]Prikryl 2013 | None reported | None reported | Consent withdrawn prior to study=1 | Consent withdrawn prior to study=1 |
| [31]Prikryl 2014\* | Headache=1 | None reported | Headache=1 | Withdrawal of consent=1 |
| [32]Quan 2015 | Headache=3 | Headache=2 | No dropouts reported | No dropouts reported |
| [37]Rabany 2014 | None reported | None reported | Inadequate motor threshold response=2 | |
| [33]Rosa 2007 | Site discomfort=4 | Headache=1  Site discomfort=1 | No dropouts reported | No dropouts reported |
| [21]Rosenberg 2012\* | Mild headache n=1 | None reported | exacerbation of psychotic symptoms=3  inability to tolerate=1 | Inability to tolerate =1  Reasons unspecified=1  Worsening psychosis= 2 |
| [34]Saba 2006 | Headache=2; allocation unspecified | | Withdrawal of consent prior to study=2 | |
| [19]Slotema 2011 | Facial  muscle twitching=7  Headache=8  Scalp discomfort=1  Cervical pain=1  Nausea=1  Dizziness=1  Abdominal pain=1  Fatigue=1 | Subjective facial muscle twitching=1  Dizziness=1 | Facial muscle twitching=2  Worsening psychosis=2  Headache=1  Unable to attend=3 | Worsening psychosis=3  Dizziness/tremor=1  Reasons unspecified=2 |
| [20]Vercammen 2009 | Facial muscle twitching=7  Headache=8  Contralateral arm tingling=1  Exacerbation of pre-existing restless legs syndrome=1  Light headedness=1  Ear pain=1 | Headache=1  Ear tingling=1 | No dropouts reported | No dropouts reported |
| [35]Wobrock 2015 | Headache=12  Facial muscle twitch=3  Fatigue=1  Psychotic ideation=1  Site discomfort=1 | Headache=4  Facial muscle twitch=3  Fatigue=1  Psychotic ideation=1 | Withdrew consent=9  Deterioration of symptoms =1  Discharged from hospital=1  Unreliable attendance=1  Headache=1 | Withdrew consent=5  Deterioration of symptoms=3  Discharged from service=3  Unreliable attendance=5  fatigue=1 |
| [36]Zhao 2014\* | Insomnia=5  Headache=1 | Headache=1 | headache=1 | Headache=1  Relocation=1 |
| **Total** | **245** | **145** | **56** | **44** |
| rTMS=repetitive Transcranial Magnetic Stimulation; \* patients contributed to the reporting of adverse events but were not included in the analyses of efficacy | | | | |

**Supplemental Figure S1: PRISMA Flow Diagram for tDCS in schizophrenia**

Studies included in quantitative synthesis (meta-analysis)  
(n = 6)

Full-text articles excluded   
(n = 42)

Records excluded   
(n = 66)

Records screened   
(n =115)

Records after duplicates removed   
(n = 115)

Full-text articles assessed for eligibility   
(n = 49)

Studies included in qualitative synthesis   
(n = 7)

Additional records identified through other sources   
(n = 0)

Records identified through database searching   
(n = 323)

## Screening

## Included

## Eligibility

## Identification

**Supplemental Figure S2: PRISMA Flow Diagram for rTMS studies on schizophrenia**

Studies included in quantitative synthesis (meta-analysis)  
(n = 30)

Full-text articles excluded (n = 103)

Records excluded   
(n = 380)

Records screened   
(n =500)

Records after duplicates removed   
(n = 500)

Studies included in qualitative synthesis   
(n = 30)

Full-text articles assessed for eligibility   
(n = 133)

Additional records identified through other sources   
(n = 0)

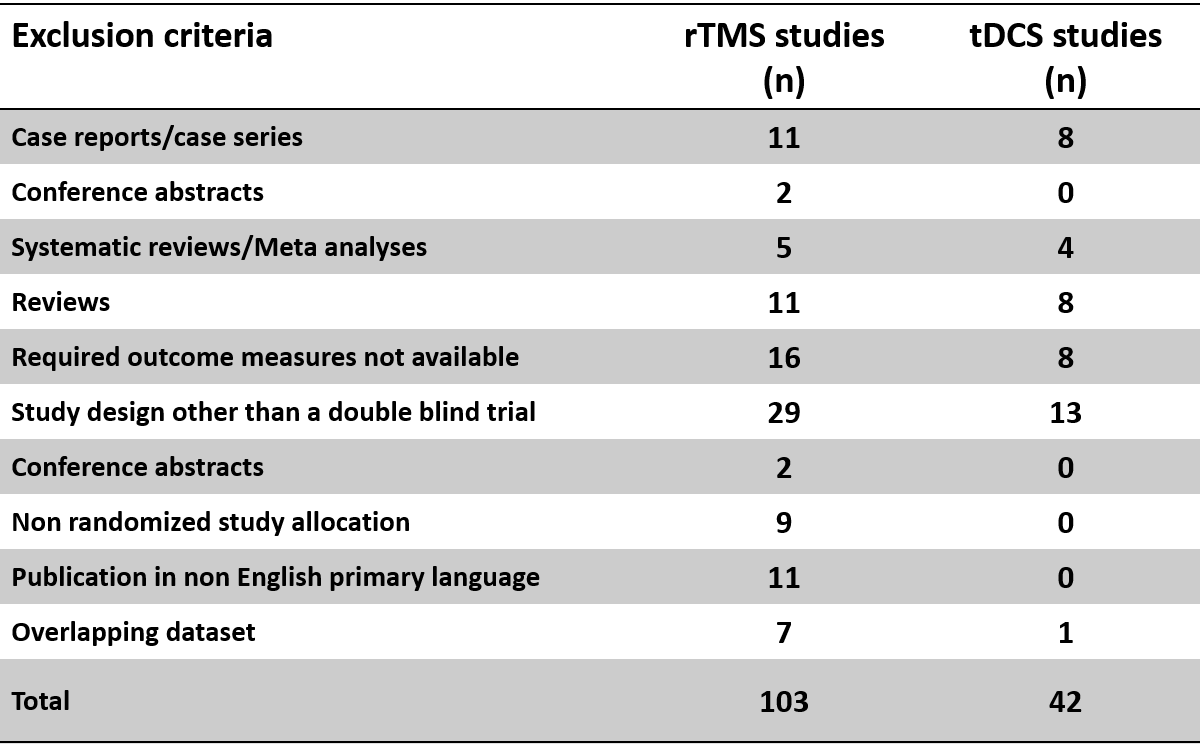
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## Screening

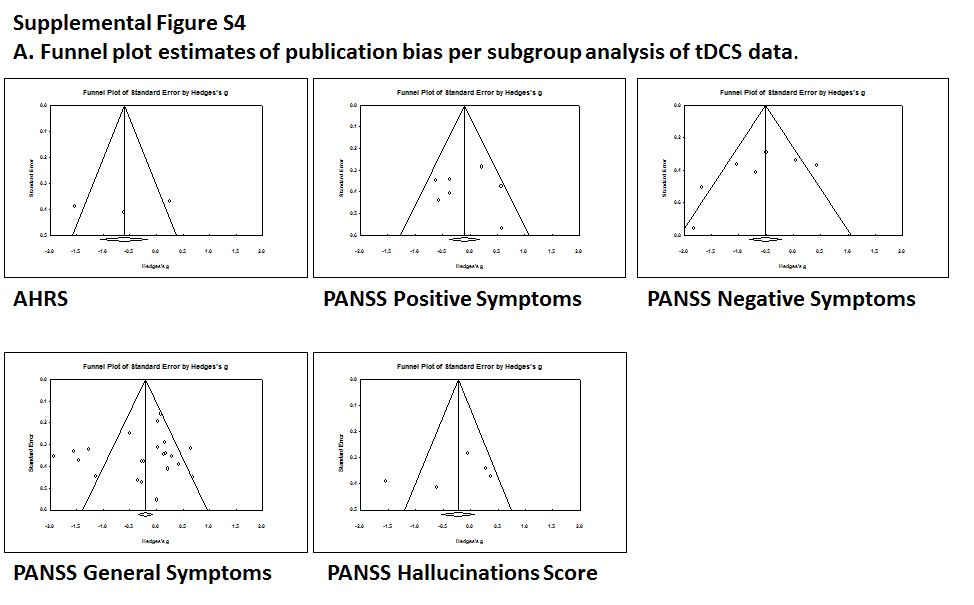
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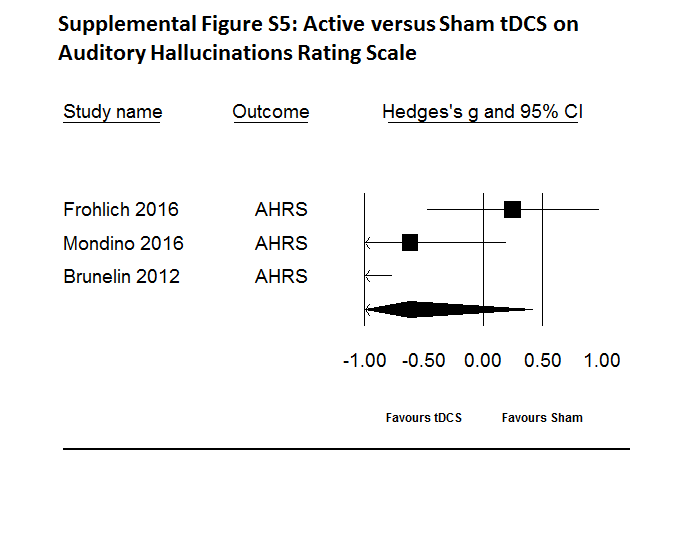
## Eligibility

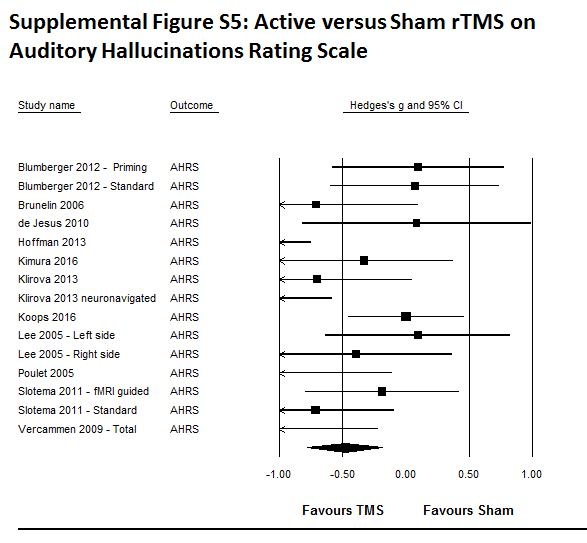
## Identification

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**Supplemental Figure S3: Reasons for study exclusion**

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**References**

[1] Fröhlich F, Burrello TN, Mellin JM, Cordle AL, Lustenberger CM, Gilmore JH, et al. Exploratory study of once-daily transcranial direct current stimulation (tDCS) as a treatment for auditory hallucinations in schizophrenia. Eur Psychiatry 2016;33:54–60. doi:10.1016/j.eurpsy.2015.11.005.

[2] Mondino M, Brunelin J, Palm U, Brunoni AR, Poulet E, Fecteau S. Transcranial direct current stimulation for the treatment of refractory symptoms of schizophrenia. Current evidence and future directions. Curr Pharm Des 2015:3373–83.

[3] Brunelin J, Mondino M, Gassab L, Haesebaert F, Gaha L, Suaud-Chagny M-FF, et al. Examining transcranial direct-current stimulation (tDCS) as a treatment for hallucinations in schizophrenia. Am J Psychiatry 2012;169:719–24. doi:10.1176/appi.ajp.2012.11071091.

[4] Fitzgerald PB, McQueen S, Daskalakis ZJ, Hoy KE. A Negative Pilot Study of Daily Bimodal Transcranial Direct Current Stimulation in Schizophrenia. Brain Stimul 2014;7:813–6. doi:10.1016/j.brs.2014.08.002.

[5] Gomes JS, Shiozawa P, Dias ÁM, Valverde Ducos D, Akiba H, Trevizol AP, et al. Left Dorsolateral Prefrontal Cortex Anodal tDCS Effects on Negative Symptoms in Schizophrenia. Brain Stimul 8:989–91. doi:10.1016/j.brs.2015.07.033.

[6] Mondino M, Jardri R, Suaud-Chagny M-F, Saoud M, Poulet E, Brunelin J. Effects of Fronto-Temporal Transcranial Direct Current Stimulation on Auditory Verbal Hallucinations and Resting-State Functional Connectivity of the Left Temporo-Parietal Junction in Patients With Schizophrenia. Schizophr Bull 2016;42:318–26. doi:10.1093/schbul/sbv114.

[7] Smith RC, Boules S, Mattiuz S, Youssef M, Tobe RH, Sershen H, et al. Effects of transcranial direct current stimulation (tDCS) on cognition, symptoms, and smoking in schizophrenia: A randomized controlled study. Schizophr Res 2015;168:260–6. doi:10.1016/j.schres.2015.06.011.

[8] Palm U, Keeser D, Hasan A, Kupka MJ, Blautzik J, Sarubin N, et al. Prefrontal Transcranial Direct Current Stimulation for Treatment of Schizophrenia With Predominant Negative Symptoms: A Double-Blind, Sham-Controlled Proof-of-Concept Study. Schizophr Bull 2016;42:1253–61. doi:10.1093/schbul/sbw041.

[9] Blumberger DM, Christensen BK, Zipursky RB, Moller B, Chen R, Fitzgerald PB, et al. MRI-targeted repetitive transcranial magnetic stimulation of Heschl’s gyrus for refractory auditory hallucinations. Brain Stimul 2012;5:577–85. doi:10.1016/j.brs.2011.12.002.

[10] Brunelin J, Poulet E, Bediou B, Kallel L, Dalery J, D’amato T, et al. Low frequency repetitive transcranial magnetic stimulation improves source monitoring deficit in hallucinating patients with schizophrenia. Schizophr Res 2006;81:41–5. doi:10.1016/j.schres.2005.10.009.

[11] de Jesus DR, Gil A, Barbosa L, Lobato MI, Magalhães PV da S, Favalli GP de S, et al. A pilot double-blind sham-controlled trial of repetitive transcranial magnetic stimulation for patients with refractory schizophrenia treated with clozapine. Psychiatry Res 2011;188:203–7. doi:10.1016/j.psychres.2010.11.022.

[12] Hoffman RE, Gueorguieva R, Hawkins KA, Varanko M, Boutros NN, Wu Y, et al. Temporoparietal transcranial magnetic stimulation for auditory hallucinations: safety, efficacy and moderators in a fifty patient sample. Biol Psychiatry 2005;58:97–104. doi:10.1016/j.biopsych.2005.03.041.

[13] Hoffman RE, Wu K, Pittman B, Cahill JD, Hawkins KA, Fernandez T, et al. Transcranial magnetic stimulation of Wernicke’s and Right homologous sites to curtail “voices”: a randomized trial. Biol Psychiatry 2013;73:1008–14. doi:10.1016/j.biopsych.2013.01.016.

[14] Kimura H, Kanahara N, Takase M, Yoshida T, Watanabe H, Iyo M. A randomized, sham-controlled study of high frequency rTMS for auditory hallucination in schizophrenia. Psychiatry Res 2016;241:190–4. doi:10.1016/j.psychres.2016.04.119.

[15] Klirova M, Horacek J, Novak T, Cermak J, Spaniel F, Skrdlantova L, et al. Individualized rTMS neuronavigated according to regional brain metabolism ((18)FGD PET) has better treatment effects on auditory hallucinations than standard positioning of rTMS: a double-blind, sham-controlled study. Eur Arch Psychiatry Clin Neurosci 2013;263:475–84. doi:10.1007/s00406-012-0368-x.

[16] Koops S, van Dellen E, Schutte MJL, Nieuwdorp W, Neggers SFW, Sommer IEC. Theta Burst Transcranial Magnetic Stimulation for Auditory Verbal Hallucinations: Negative Findings From a Double-Blind-Randomized Trial. Schizophr Bull 2016;42:250–7. doi:10.1093/schbul/sbv100.

[17] Lee S-H, Kim W, Chung Y-C, Jung K-H, Bahk W-M, Jun T-Y, et al. A double blind study showing that two weeks of daily repetitive TMS over the left or right temporoparietal cortex reduces symptoms in patients with schizophrenia who are having treatment-refractory auditory hallucinations. Neurosci Lett 2005;376:177–81. doi:10.1016/j.neulet.2004.11.048.

[18] Poulet E, Brunelin J, Bediou B, Bation R, Forgeard L, Dalery J, et al. Slow transcranial magnetic stimulation can rapidly reduce resistant auditory hallucinations in schizophrenia. Biol Psychiatry 2005;57:188–91. doi:10.1016/j.biopsych.2004.10.007.

[19] Slotema CW, Blom JD, de Weijer AD, Diederen KM, Goekoop R, Looijestijn J, et al. Can low-frequency repetitive transcranial magnetic stimulation really relieve medication-resistant auditory verbal hallucinations? Negative results from a large randomized controlled trial. Biol Psychiatry 2011;69:450–6. doi:10.1016/j.biopsych.2010.09.051.

[20] Vercammen A, Knegtering H, Bruggeman R, Westenbroek HM, Jenner JA, Slooff CJ, et al. Effects of bilateral repetitive transcranial magnetic stimulation on treatment resistant auditory-verbal hallucinations in schizophrenia: a randomized controlled trial. Schizophr Res 2009;114:172–9. doi:10.1016/j.schres.2009.07.013.

[21] Rosenberg O, Gersner R, Klein LD, Kotler M, Zangen A, Dannon P. Deep transcranial magnetic stimulation add-on for the treatment of auditory hallucinations: a double-blind study. Ann Gen Psychiatry 2012;11:13. doi:10.1186/1744-859X-11-13.

[22] McIntosh AM, Semple D, Tasker K, Harrison LK, Owens DGC, Johnstone EC, et al. Transcranial magnetic stimulation for auditory hallucinations in schizophrenia. Psychiatry Res 2004;127:9–17. doi:10.1016/j.psychres.2004.03.005.

[23] Barr MS, Farzan F, Tran LC, Fitzgerald PB, Daskalakis ZJ. A randomized controlled trial of sequentially bilateral prefrontal cortex repetitive transcranial magnetic stimulation in the treatment of negative symptoms in schizophrenia. Brain Stimul 2012;5:337–46. doi:10.1016/j.brs.2011.06.003.

[24] Dlabac-de Lange JJ, Bais L, van Es FD, Visser BGJ, Reinink E, Bakker B, et al. Efficacy of bilateral repetitive transcranial magnetic stimulation for negative symptoms of schizophrenia: results of a multicenter double-blind randomized controlled trial. Psychol Med 2015;45:1263–75. doi:10.1017/S0033291714002360.

[25] Fitzgerald PB, Benitez J, Daskalakis JZ, Brown TL, Marston NAU, de Castella A, et al. A double-blind sham-controlled trial of repetitive transcranial magnetic stimulation in the treatment of refractory auditory hallucinations. J Clin Psychopharmacol 2005;25:358–62.

[26] Fitzgerald PB, Herring S, Hoy K, McQueen S, Segrave R, Kulkarni J, et al. A study of the effectiveness of bilateral transcranial magnetic stimulation in the treatment of the negative symptoms of schizophrenia. Brain Stimul 2008;1:27–32. doi:10.1016/j.brs.2007.08.001.

[27] Garg S, Sinha VK, Tikka SK, Mishra P, Goyal N. The efficacy of cerebellar vermal deep high frequency (theta range) repetitive transcranial magnetic stimulation (rTMS) in schizophrenia: A randomized rater blind-sham controlled study. Psychiatry Res 2016;243:413–20. doi:10.1016/j.psychres.2016.07.023.

[28] Holi MM, Eronen M, Toivonen K, Toivonen P, Marttunen M, Naukkarinen H. Left prefrontal repetitive transcranial magnetic stimulation in schizophrenia. Schizophr Bull 2004;30:429–34.

[29] Klein E, Kolsky Y, Puyerovsky M, Koren D, Chistyakov A, Feinsod M. Right prefrontal slow repetitive transcranial magnetic stimulation in schizophrenia: a double-blind sham-controlled pilot study. Biol Psychiatry 1999;46:1451–4.

[30] Prikryl R, Kasparek T, Skotakova S, Ustohal L, Kucerova H, Ceskova E. Treatment of negative symptoms of schizophrenia using repetitive transcranial magnetic stimulation in a double-blind, randomized controlled study. Schizophr Res 2007;95:151–7. doi:10.1016/j.schres.2007.06.019.

[31] Prikryl R, Ustohal L, Kucerova HP, Kasparek T, Jarkovsky J, Hublova V, et al. Repetitive transcranial magnetic stimulation reduces cigarette consumption in schizophrenia patients. Prog Neuropsychopharmacol Biol Psychiatry 2014;49:30–5. doi:10.1016/j.pnpbp.2013.10.019.

[32] Quan WX, Zhu XL, Qiao H, Zhang WF, Tan SP, Zhou DF, et al. The effects of high-frequency repetitive transcranial magnetic stimulation (rTMS) on negative symptoms of schizophrenia and the follow-up study. Neurosci Lett 2015;584:197–201. doi:10.1016/j.neulet.2014.10.029.

[33] Rosa MO, Gattaz WF, Rosa MA, Rumi DO, Tavares H, Myczkowski M, et al. Effects of repetitive transcranial magnetic stimulation on auditory hallucinations refractory to clozapine. J Clin Psychiatry 2007;68:1528–32.

[34] Saba G, Verdon CM, Kalalou K, Rocamora JF, Dumortier G, Benadhira R, et al. Transcranial magnetic stimulation in the treatment of schizophrenic symptoms: a double blind sham controlled study. J Psychiatr Res 2006;40:147–52. doi:10.1016/j.jpsychires.2005.02.008.

[35] Wobrock T, Guse B, Cordes J, Wölwer W, Winterer G, Gaebel W, et al. Left prefrontal high-frequency repetitive transcranial magnetic stimulation for the treatment of schizophrenia with predominant negative symptoms: a sham-controlled, randomized multicenter trial. Biol Psychiatry 2015;77:979–88. doi:10.1016/j.biopsych.2014.10.009.

[36] Zhao S, Kong J, Li S, Tong Z, Yang C, Zhong H. Randomized controlled trial of four protocols of repetitive transcranial magnetic stimulation for treating the negative symptoms of schizophrenia. Shanghai Arch Psychiatry 2014;26:15–21. doi:10.3969/j.issn.1002-0829.2014.01.003.

[37] Rabany L, Deutsch L, Levkovitz Y. Double-blind, randomized sham controlled study of deep-TMS add-on treatment for negative symptoms and cognitive deficits in schizophrenia. J Psychopharmacol 2014;28:686–90. doi:10.1177/0269881114533600.

[38] Li Z, Yin M, Lyu X-L, Zhang L-L, Du X-D, Hung GC-L. Delayed effect of repetitive transcranial magnetic stimulation (rTMS) on negative symptoms of schizophrenia: Findings from a randomized controlled trial. Psychiatry Res 2016;240:333–5. doi:10.1016/j.psychres.2016.04.046.

[39] Prikryl R, Ustohal L, Prikrylova Kucerova H, Kasparek T, Venclikova S, Vrzalova M, et al. A detailed analysis of the effect of repetitive transcranial magnetic stimulation on negative symptoms of schizophrenia: a double-blind trial. Schizophr Res 2013;149:167–73. doi:10.1016/j.schres.2013.06.015.