Digital Cognitive Behavioral Therapy for Insomnia on Depression and Anxiety: A Systematic Review and Meta-analysis

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SUPPLEMENTARY MATERIALS

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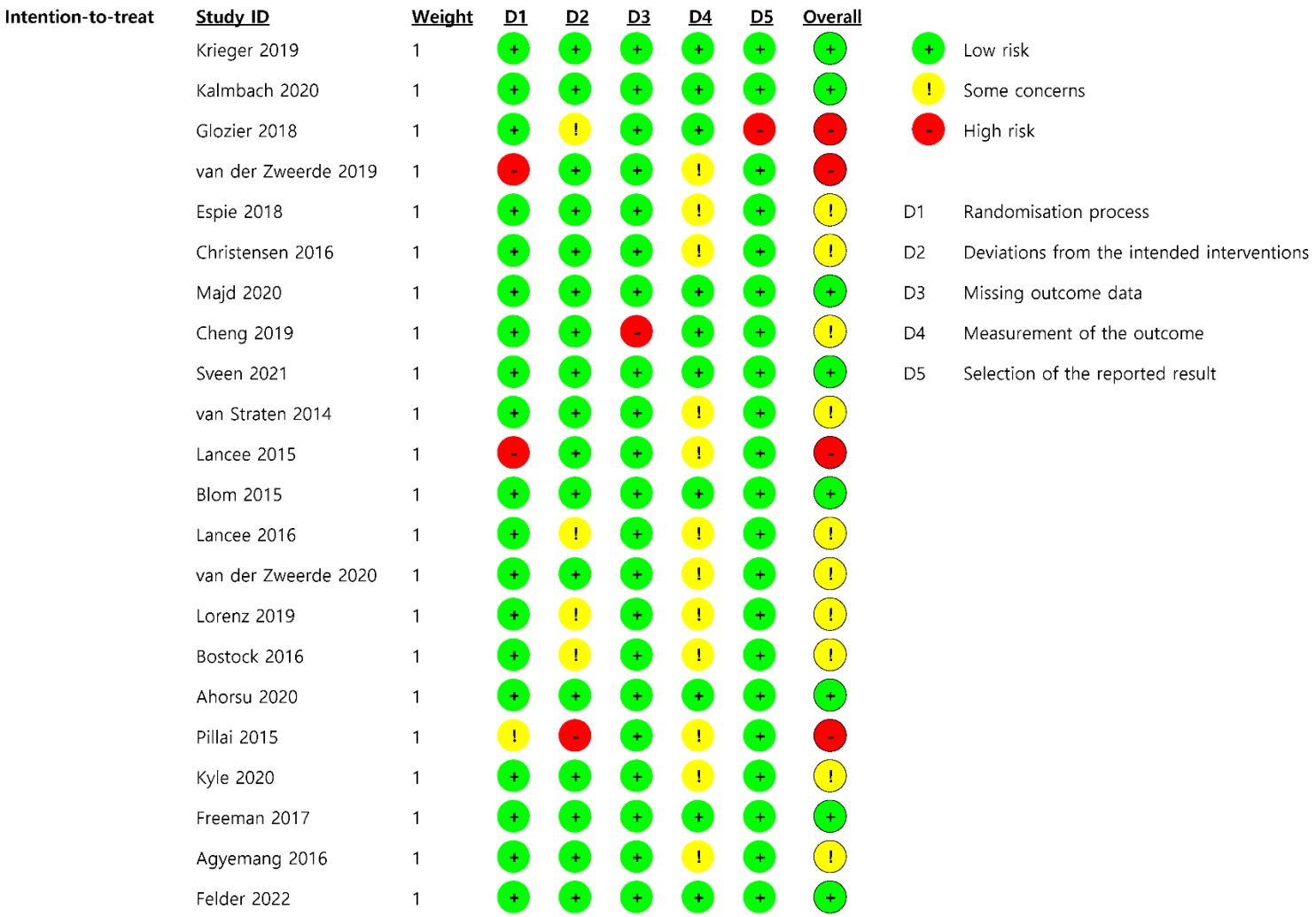
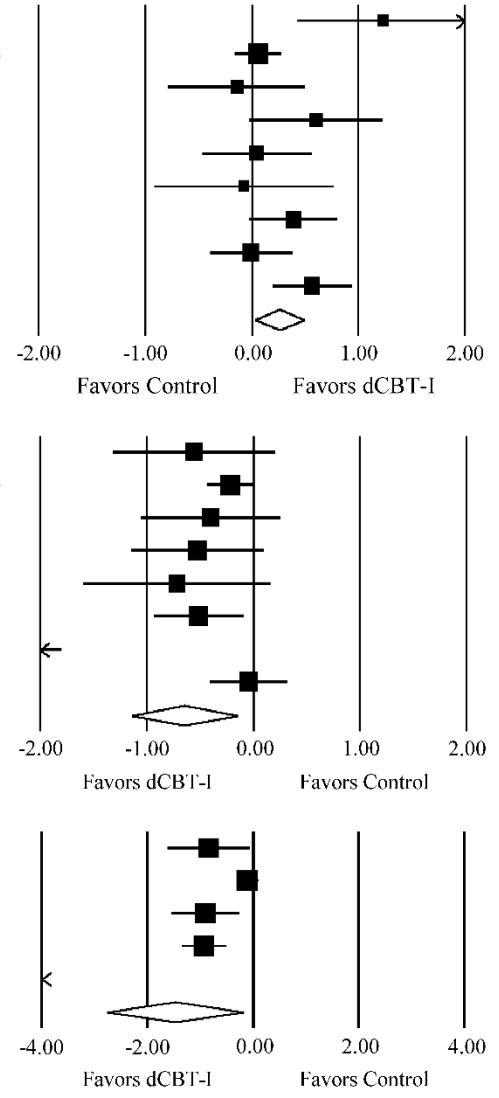
Supplementary Table 1. Search Query in Intervention and Outcome Domains

Intervention	Outcome
(CBT OR cognitive behavioral therapy OR cognitive therapy OR behavioral therapy) AND (digital OR internet OR online OR web OR telephone OR mobile OR app OR application OR smartphone OR computer OR computerized OR ehealth)	(depress* OR anxiety) AND (insomnia OR sleep)



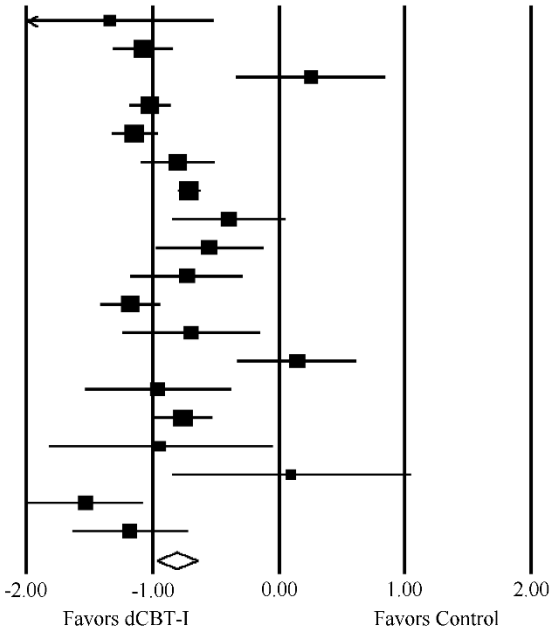
Supplementary Figure 1. Risk of Bias Assessment

Study Name	Statistics for Each Study							Sample Size		Std Difference in Means and 95% CI	Relative Weight
	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Intervention	Control		
Total Sleep Time											
Agyemang et al. (2017)	1.236	0.412	0.170	0.427	2.044	2.996	0.003	14	14		5.90
Ahorsu et al. (2020)	0.063	0.112	0.013	-0.156	0.283	0.567	0.571	160	160		19.30
Blom et al. (2015)	-0.136	0.327	0.107	-0.776	0.504	-0.417	0.676	17	21		8.19
Lancee et al. (2015)	0.607	0.316	0.100	-0.012	1.227	1.922	0.055	25	18		8.55
Lancee et al. (2016)	0.053	0.261	0.068	-0.458	0.564	0.203	0.839	21	49		10.73
Pillai et al. (2015)	-0.069	0.434	0.188	-0.920	0.781	-0.160	0.873	13	9		5.47
van der Zweerde et al. (2019)	0.395	0.211	0.044	-0.018	0.807	1.874	0.061	45	47		13.23
van der Zweerde et al. (2020)	-0.003	0.195	0.038	-0.386	0.380	-0.014	0.989	55	50		14.09
van Straten et al. (2014)	0.571	0.188	0.035	0.203	0.939	3.039	0.002	59	59		14.53
Overall random effects model	0.263	0.116	0.013	0.036	0.490	2.268	0.023				
Sleep Onset Latency											
Agyemang et al. (2017)	-0.552	0.385	0.148	-1.307	0.203	-1.433	0.152	14	14		11.07
Ahorsu et al. (2020)	-0.210	0.112	0.013	-0.430	0.009	-1.875	0.061	160	160		14.48
Blom et al. (2015)	-0.396	0.329	0.109	-1.042	0.249	-1.204	0.229	17	21		11.89
Lancee et al. (2015)	-0.519	0.314	0.099	-1.135	0.097	-1.653	0.098	25	18		12.11
Pillai et al. (2015)	-0.713	0.447	0.200	-1.589	0.162	-1.597	0.110	13	9		10.16
van der Zweerde et al. (2019)	-0.508	0.212	0.045	-0.923	-0.092	-2.395	0.017	45	47		13.49
van der Zweerde et al. (2020)	-2.288	0.251	0.063	-2.780	-1.795	-9.107	0.000	55	50		12.99
van Straten et al. (2014)	-0.041	0.184	0.034	-0.402	0.320	-0.222	0.824	59	59		13.81
Overall random effects model	-0.645	0.253	0.064	-1.140	-0.150	-2.555	0.011				
Wake After Sleep Onset											
Agyemang et al. (2017)	-0.843	0.394	0.156	-1.616	-0.070	-2.138	0.033	14	14		19.42
Ahorsu et al. (2020)	-0.106	0.112	0.013	-0.325	0.114	-0.944	0.345	160	160		20.77
Lancee et al. (2015)	-0.901	0.324	0.105	-1.536	-0.266	-2.780	0.005	25	18		19.88
van der Zweerde et al. (2019)	-0.925	0.219	0.048	-1.356	-0.495	-4.217	0.000	45	47		20.42
van der Zweerde et al. (2020)	-4.745	0.381	0.145	-5.492	-3.998	-12.444	0.000	55	50		19.51
Overall random effects model	-1.480	0.655	0.429	-2.763	-0.196	-2.260	0.024				



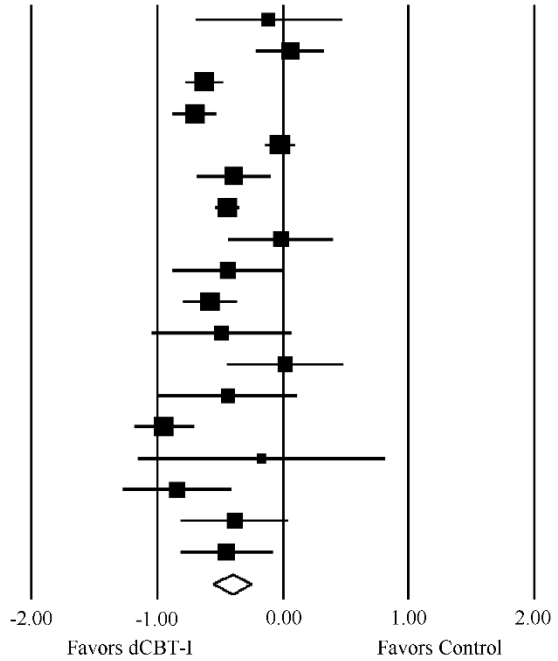
Supplementary Figure 2. Meta-analysis of the effect of dCBT-I on Sleep Diary Measures

Study Name	Statistics for Each Study							Sample Size		Relative Weight
	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Intervention	Control	
Agyemang et al. (2017)	-1.340	0.418	0.175	-2.159	-0.520	-3.203	0.001	14	14	2.58
Ahorsu et al. (2020)	-1.077	0.120	0.014	-1.312	-0.843	-9.003	0.000	160	160	7.08
Blom et al. (2015)	0.255	0.299	0.090	-0.332	0.842	0.851	0.395	22	23	3.89
Cheng et al. (2018)	-1.021	0.083	0.007	-1.184	-0.858	-12.271	0.000	358	300	7.70
Christensen et al. (2016)	-1.143	0.090	0.008	-1.320	-0.966	-12.650	0.000	248	333	7.59
Felder et al. (2020)	-0.799	0.153	0.023	-1.099	-0.500	-5.230	0.000	91	94	6.45
Freeman et al. (2017)	-0.711	0.049	0.002	-0.806	-0.615	-14.583	0.000	733	1142	8.13
Gloizer et al. (2019)	-0.395	0.234	0.055	-0.853	0.063	-1.690	0.091	40	35	4.92
Kalmbach et al. (2020)	-0.548	0.215	0.046	-0.969	-0.127	-2.551	0.011	46	44	5.26
Krieger et al. (2019)	-0.729	0.226	0.051	-1.171	-0.286	-3.228	0.001	34	54	5.06
Kyle et al. (2020)	-1.176	0.118	0.014	-1.408	-0.944	-9.927	0.000	155	181	7.10
Lancee et al. (2015)	-0.696	0.278	0.077	-1.241	-0.151	-2.502	0.012	36	22	4.20
Lancee et al. (2016)	0.145	0.238	0.057	-0.322	0.612	0.610	0.542	26	55	4.84
Lorenz et al. (2018)	-0.961	0.293	0.086	-1.536	-0.387	-3.279	0.001	25	27	3.98
Majd et al. (2020)	-0.759	0.117	0.014	-0.988	-0.529	-6.471	0.000	156	156	7.12
Pillai et al. (2015)	-0.936	0.456	0.208	-1.830	-0.043	-2.054	0.040	13	9	2.28
Sveen et al. (2021)	0.100	0.486	0.236	-0.853	1.053	0.206	0.837	9	8	2.07
van der Zweerde et al. (2019)	-1.533	0.237	0.056	-1.998	-1.068	-6.463	0.000	45	47	4.86
van der Zweerde et al. (2020)	-1.181	0.237	0.056	-1.644	-0.717	-4.991	0.000	43	41	4.87
Overall random effects model	-0.810	0.081	0.007	-0.968	-0.652	-10.033	0.000			



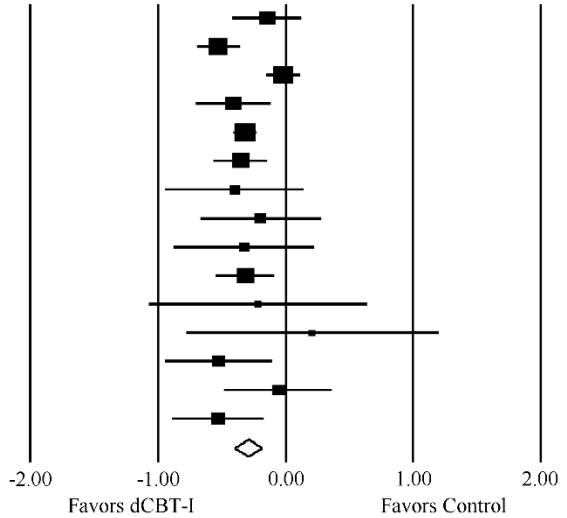
Supplementary Figure 3. Meta-analysis of the effect of dCBT-I on Sleep Outcome (ISI only)

Study Name	Statistics for Each Study							Sample Size		Std Difference in Means and 95% CI	Relative Weight
	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Intervention	Control		
Blom et al. (2015)	-0.107	0.298	0.089	-0.692	0.478	-0.360	0.719	22	23		3.66
Bostock et al. (2016)	0.062	0.137	0.019	-0.207	0.331	0.452	0.651	98	116		6.46
Cheng et al. (2018)	-0.624	0.080	0.006	-0.781	-0.467	-7.786	0.000	358	300		7.47
Christensen et al. (2016)	-0.697	0.086	0.007	-0.866	-0.527	-8.068	0.000	248	333		7.38
Espie et al. (2019)	-0.019	0.064	0.004	-0.144	0.106	-0.292	0.770	468	517		7.70
Felder et al. (2020)	-0.386	0.148	0.022	-0.677	-0.095	-2.601	0.009	91	94		6.25
Freeman et al. (2017)	-0.435	0.048	0.002	-0.529	-0.341	-9.088	0.000	733	1142		7.88
Kalmbach et al. (2020)	-0.012	0.211	0.044	-0.426	0.401	-0.059	0.953	46	44		5.05
Krieger et al. (2019)	-0.432	0.222	0.049	-0.867	0.003	-1.945	0.052	34	53		4.85
Kyle et al. (2020)	-0.574	0.112	0.012	-0.792	-0.355	-5.137	0.000	155	181		6.94
Lancee et al. (2015)	-0.482	0.281	0.079	-1.033	0.068	-1.718	0.086	32	22		3.91
Lancee et al. (2016)	0.023	0.238	0.057	-0.444	0.489	0.095	0.924	26	55		4.58
Lorenz et al. (2018)	-0.431	0.281	0.079	-0.982	0.119	-1.536	0.124	25	27		3.91
Majd et al. (2020)	-0.943	0.119	0.014	-1.177	-0.709	-7.901	0.000	156	156		6.80
Sveen et al. (2021)	-0.166	0.501	0.251	-1.147	0.816	-0.330	0.741	8	8		1.83
van der Zweerde et al. (2018)	-0.839	0.218	0.047	-1.266	-0.413	-3.857	0.000	45	47		4.93
Van der Zweerde et al. (2020)	-0.378	0.220	0.048	-0.809	0.054	-1.716	0.086	43	41		4.88
Van Straten et al. (2014)	-0.444	0.186	0.035	-0.809	-0.079	-2.382	0.017	59	59		5.51
Overall random effects model	-0.405	0.077	0.006	-0.556	-0.254	-5.264	0.000				



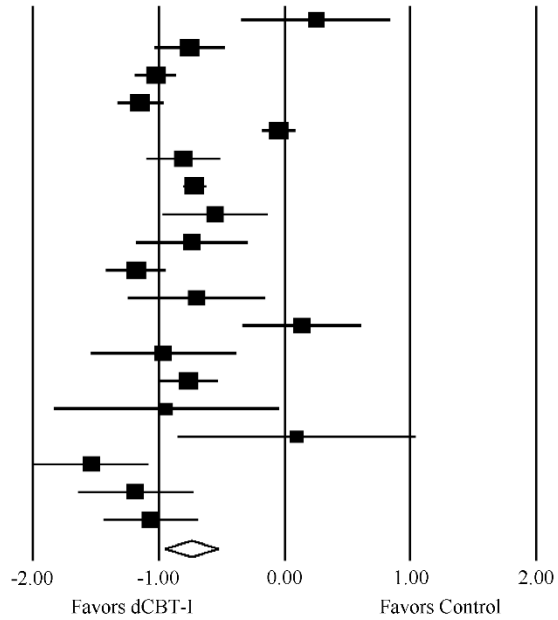
Supplementary Figure 4. The effect of dCBT-I on Depression Outcome (Comorbidity Removed)

Study Name	Statistics for Each Study							Sample Size		Std Difference in Means and 95% CI	Relative Weight
	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Intervention	Control		
Bostock et al. (2016)	-0.141	0.137	0.019	-0.410	0.128	-1.025	0.305	98	116		7.94
Christensen et al. (2016)	-0.522	0.085	0.007	-0.690	-0.355	-6.127	0.000	248	333		11.29
Espie et al. (2019)	-0.014	0.064	0.004	-0.139	0.111	-0.224	0.823	468	517		12.78
Felder et al. (2020)	-0.405	0.149	0.022	-0.696	-0.114	-2.724	0.006	91	94		7.34
Freeman et al. (2017)	-0.313	0.048	0.002	-0.407	-0.220	-6.579	0.000	733	1142		13.80
Kyle et al. (2020)	-0.346	0.110	0.012	-0.562	-0.129	-3.134	0.002	155	181		9.59
Lancee et al. (2015)	-0.393	0.280	0.078	-0.941	0.155	-1.405	0.160	32	22		3.16
Lancee et al. (2016)	-0.191	0.238	0.057	-0.659	0.276	-0.803	0.422	26	55		4.03
Lorenz et al. (2018)	-0.320	0.279	0.078	-0.868	0.227	-1.147	0.252	25	27		3.16
Majd et al. (2020)	-0.311	0.114	0.013	-0.534	-0.088	-2.730	0.006	156	156		9.35
Pillai et al. (2015)	-0.210	0.435	0.189	-1.062	0.642	-0.482	0.630	13	9		1.48
Sveen et al. (2021)	0.215	0.501	0.251	-0.768	1.198	0.429	0.668	8	8		1.14
van der Zweerde et al. (2018)	-0.521	0.212	0.045	-0.936	-0.105	-2.456	0.014	45	47		4.76
Van der Zweerde et al. (2020)	-0.053	0.218	0.048	-0.481	0.375	-0.243	0.808	43	41		4.57
Van Straten et al. (2014)	-0.526	0.187	0.035	-0.893	-0.159	-2.810	0.005	59	59		5.61
Overall random effects model	-0.295	0.056	0.003	-0.404	-0.186	-5.291	0.000				



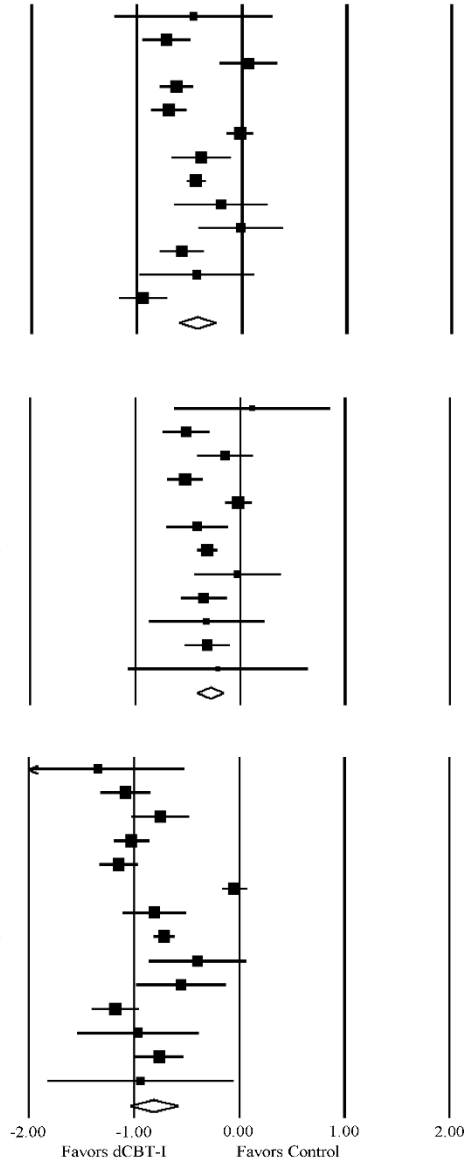
Supplementary Figure 5. The effect of dCBT-I on Anxiety Outcome (Comorbidity Removed)

Study Name	Statistics for Each Study							Sample Size		Std Difference in Means and 95% CI	Relative Weight
	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Intervention	Control		
Blom et al. (2015)	0.255	0.299	0.090	-0.332	0.842	0.851	0.395	22	23		4.37
Bostock et al. (2016)	-0.749	0.142	0.020	-1.027	-0.471	-5.279	0.000	98	116		5.96
Cheng et al. (2018)	-1.021	0.083	0.007	-1.184	-0.858	-12.271	0.000	358	300		6.40
Christensen et al. (2016)	-1.143	0.090	0.008	-1.320	-0.966	-12.650	0.000	248	333		6.36
Espie et al. (2019)	-0.041	0.064	0.004	-0.166	0.084	-0.646	0.518	468	517		6.50
Felder et al. (2020)	-0.799	0.153	0.023	-1.099	-0.500	-5.230	0.000	91	94		5.86
Freeman et al. (2017)	-0.711	0.049	0.002	-0.806	-0.615	-14.583	0.000	733	1142		6.57
Kalmbach et al. (2020)	-0.548	0.215	0.046	-0.969	-0.127	-2.551	0.011	46	44		5.25
Krieger et al. (2019)	-0.729	0.226	0.051	-1.171	-0.286	-3.228	0.001	34	54		5.13
Kyle et al. (2020)	-1.176	0.118	0.014	-1.408	-0.944	-9.927	0.000	155	181		6.15
Lancee et al. (2015)	-0.696	0.278	0.077	-1.241	-0.151	-2.502	0.012	36	22		4.59
Lancee et al. (2016)	0.145	0.238	0.057	-0.322	0.612	0.610	0.542	26	55		5.00
Lorenz et al. (2018)	-0.961	0.293	0.086	-1.536	-0.387	-3.279	0.001	25	27		4.43
Majd et al. (2020)	-0.759	0.117	0.014	-0.988	-0.529	-6.471	0.000	156	156		6.16
Pillai et al. (2015)	-0.936	0.456	0.208	-1.830	-0.043	-2.054	0.040	13	9		3.01
Sveen et al. (2021)	0.100	0.486	0.236	-0.853	1.053	0.206	0.837	9	8		2.80
van der Zweerde et al. (2018)	-1.533	0.237	0.056	-1.998	-1.068	-6.463	0.000	45	47		5.01
van der Zweerde et al. (2020)	-1.181	0.237	0.056	-1.644	-0.717	-4.991	0.000	43	41		5.02
van Straten et al. (2014)	-1.059	0.197	0.039	-1.444	-0.673	-5.385	0.000	59	59		5.43
Overall random effects model	-0.739	0.107	0.011	-0.948	-0.530	-6.924	0.000				

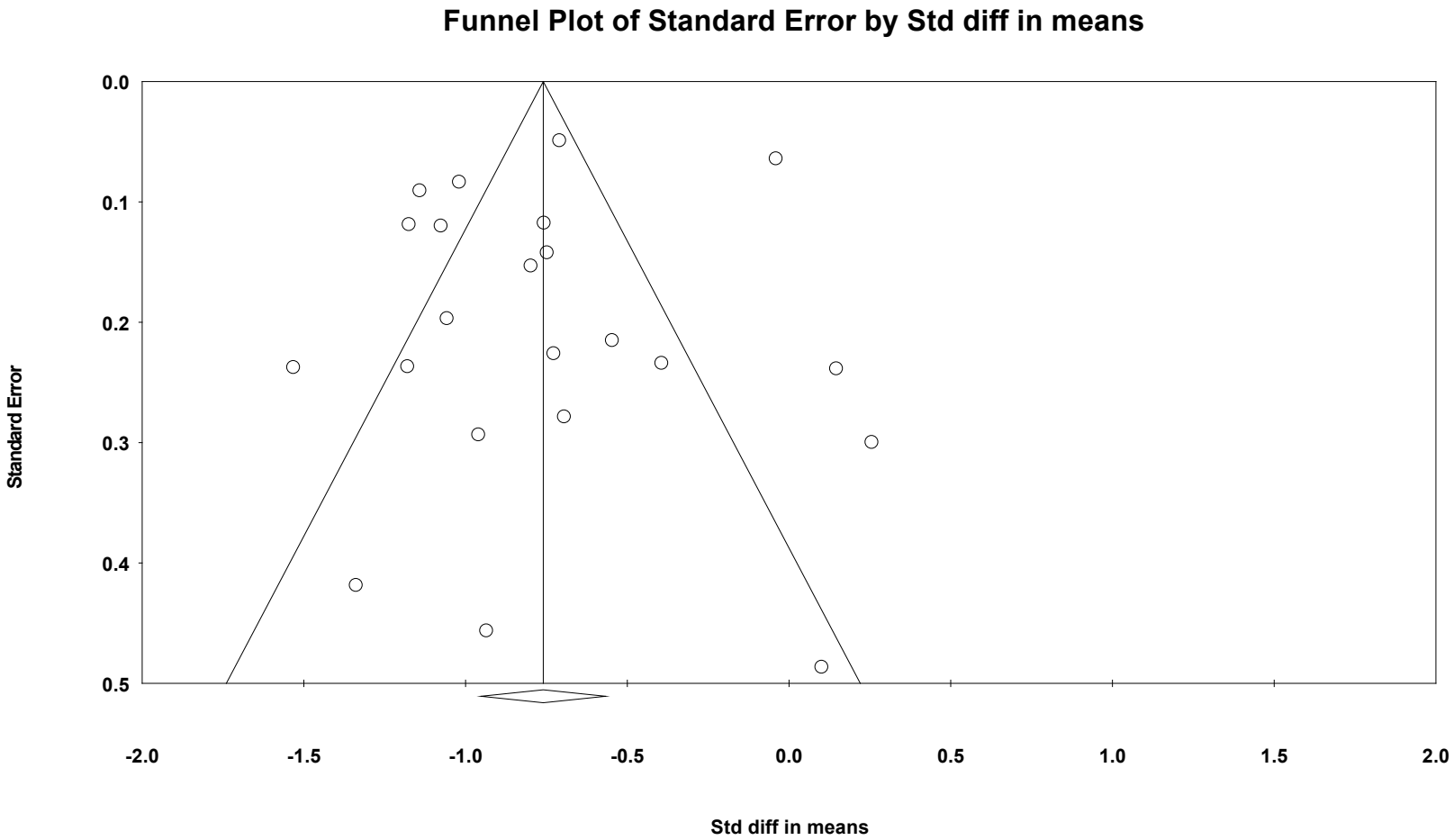


Supplementary Figure 6. The effect of dCBT-I on Sleep Outcome (Comorbidity Removed)

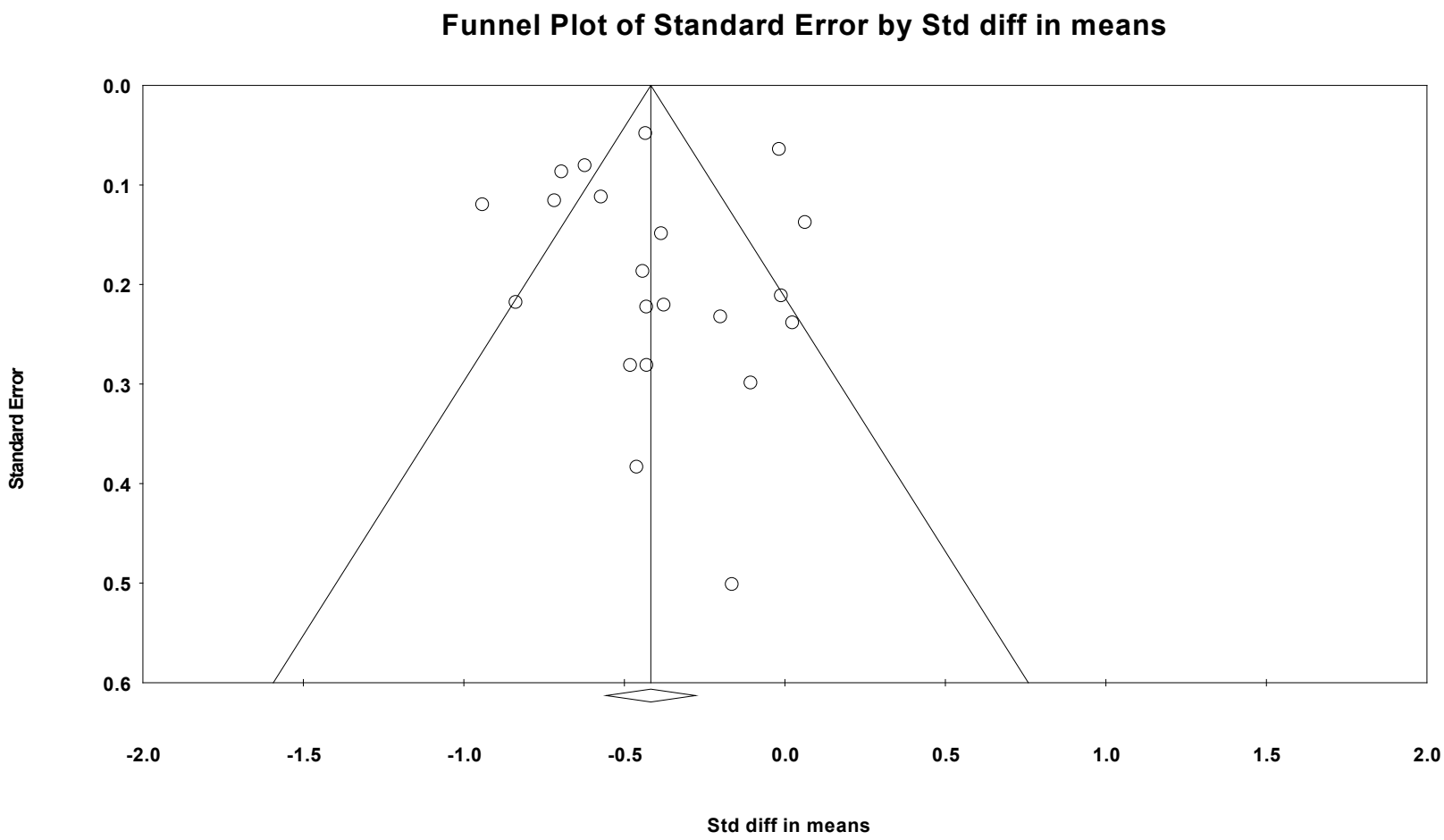
Study Name	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Intervention	Control	Relative Weight
Depression										
Agyemang et al. (2017)	-0.463	0.383	0.147	-1.213	0.288	-1.208	0.227	14	14	3.51
Ahorsu et al. (2020)	-0.719	0.115	0.013	-0.945	-0.493	-6.232	0.000	160	160	8.55
Bostock et al. (2016)	0.062	0.137	0.019	-0.207	0.331	0.452	0.651	98	116	8.07
Cheng et al. (2018)	-0.624	0.080	0.006	-0.781	-0.467	-7.786	0.000	358	300	9.24
Christensen et al. (2016)	-0.697	0.086	0.007	-0.866	-0.527	-8.068	0.000	248	333	9.13
Espie et al. (2019)	-0.019	0.064	0.004	-0.144	0.106	-0.292	0.770	468	517	9.50
Felder et al. (2020)	-0.386	0.148	0.022	-0.677	-0.095	-2.601	0.009	91	94	7.82
Freeman et al. (2017)	-0.435	0.048	0.002	-0.529	-0.341	-9.088	0.000	733	1142	9.71
Glozier et al. (2019)	-0.202	0.232	0.054	-0.656	0.253	-0.869	0.385	40	35	5.95
Kalmbach et al. (2020)	-0.012	0.211	0.044	-0.426	0.401	-0.059	0.953	46	44	6.40
Kyle et al. (2020)	-0.574	0.112	0.012	-0.792	-0.355	-5.137	0.000	155	181	8.63
Lorenz et al. (2018)	-0.431	0.281	0.079	-0.982	0.119	-1.536	0.124	25	27	5.01
Majd et al. (2020)	-0.943	0.119	0.014	-1.177	-0.709	-7.901	0.000	156	156	8.47
Overall random effects model	-0.432	0.089	0.008	-0.606	-0.257	-4.851	0.000			
Anxiety										
Agyemang et al. (2017)	0.114	0.378	0.143	-0.627	0.856	0.302	0.763	14	14	2.28
Ahorsu et al. (2020)	-0.513	0.114	0.013	-0.735	-0.290	-4.512	0.000	160	160	10.14
Bostock et al. (2016)	-0.141	0.137	0.019	-0.410	0.128	-1.025	0.305	98	116	8.76
Christensen et al. (2016)	-0.522	0.085	0.007	-0.690	-0.355	-6.127	0.000	248	333	11.92
Espie et al. (2019)	-0.014	0.064	0.004	-0.139	0.111	-0.224	0.823	468	517	13.23
Felder et al. (2020)	-0.405	0.149	0.022	-0.696	-0.114	-2.724	0.006	91	94	8.16
Freeman et al. (2017)	-0.313	0.048	0.002	-0.407	-0.220	-6.579	0.000	733	1142	14.11
Glozier et al. (2019)	-0.019	0.215	0.046	-0.439	0.402	-0.088	0.930	45	42	5.40
Kyle et al. (2020)	-0.346	0.110	0.012	-0.562	-0.129	-3.134	0.002	155	181	10.35
Lorenz et al. (2018)	-0.320	0.279	0.078	-0.868	0.227	-1.147	0.252	25	27	3.72
Majd et al. (2020)	-0.311	0.114	0.013	-0.534	-0.088	-2.730	0.006	156	156	10.12
Pillai et al. (2015)	-0.210	0.435	0.189	-1.062	0.642	-0.482	0.630	13	9	1.79
Overall random effects model	-0.287	0.062	0.004	-0.408	-0.166	-4.636	0.000			
Sleep Outcome										
Agyemang et al. (2017)	-1.340	0.418	0.175	-2.159	-0.520	-3.203	0.001	14	14	4.09
Ahorsu et al. (2020)	-1.077	0.120	0.014	-1.312	-0.843	-9.003	0.000	160	160	8.02
Bostock et al. (2016)	-0.749	0.142	0.020	-1.027	-0.471	-5.279	0.000	98	116	7.75
Cheng et al. (2018)	-1.021	0.083	0.007	-1.184	-0.858	-12.271	0.000	358	300	8.39
Christensen et al. (2016)	-1.143	0.090	0.008	-1.320	-0.966	-12.650	0.000	248	333	8.33
Espie et al. (2019)	-0.041	0.064	0.004	-0.166	0.084	-0.646	0.518	468	517	8.54
Felder et al. (2020)	-0.799	0.153	0.023	-1.099	-0.500	-5.230	0.000	91	94	7.61
Freeman et al. (2017)	-0.711	0.049	0.002	-0.806	-0.615	-14.583	0.000	733	1142	8.64
Gloizer et al. (2019)	-0.395	0.234	0.055	-0.853	0.063	-1.690	0.091	40	35	6.46
Kalmbach et al. (2020)	-0.548	0.215	0.046	-0.969	-0.127	-2.551	0.011	46	44	6.74
Kyle et al. (2020)	-1.176	0.118	0.014	-1.408	-0.944	-9.927	0.000	155	181	8.03
Lorenz et al. (2018)	-0.961	0.293	0.086	-1.536	-0.387	-3.279	0.001	25	27	5.62
Majd et al. (2020)	-0.759	0.117	0.014	-0.988	-0.529	-6.471	0.000	156	156	8.05
Pillai et al. (2015)	-0.936	0.456	0.208	-1.830	-0.043	-2.054	0.040	13	9	3.72
Overall random effects model	-0.813	0.116	0.013	-1.040	-0.586	-7.012	0.000			



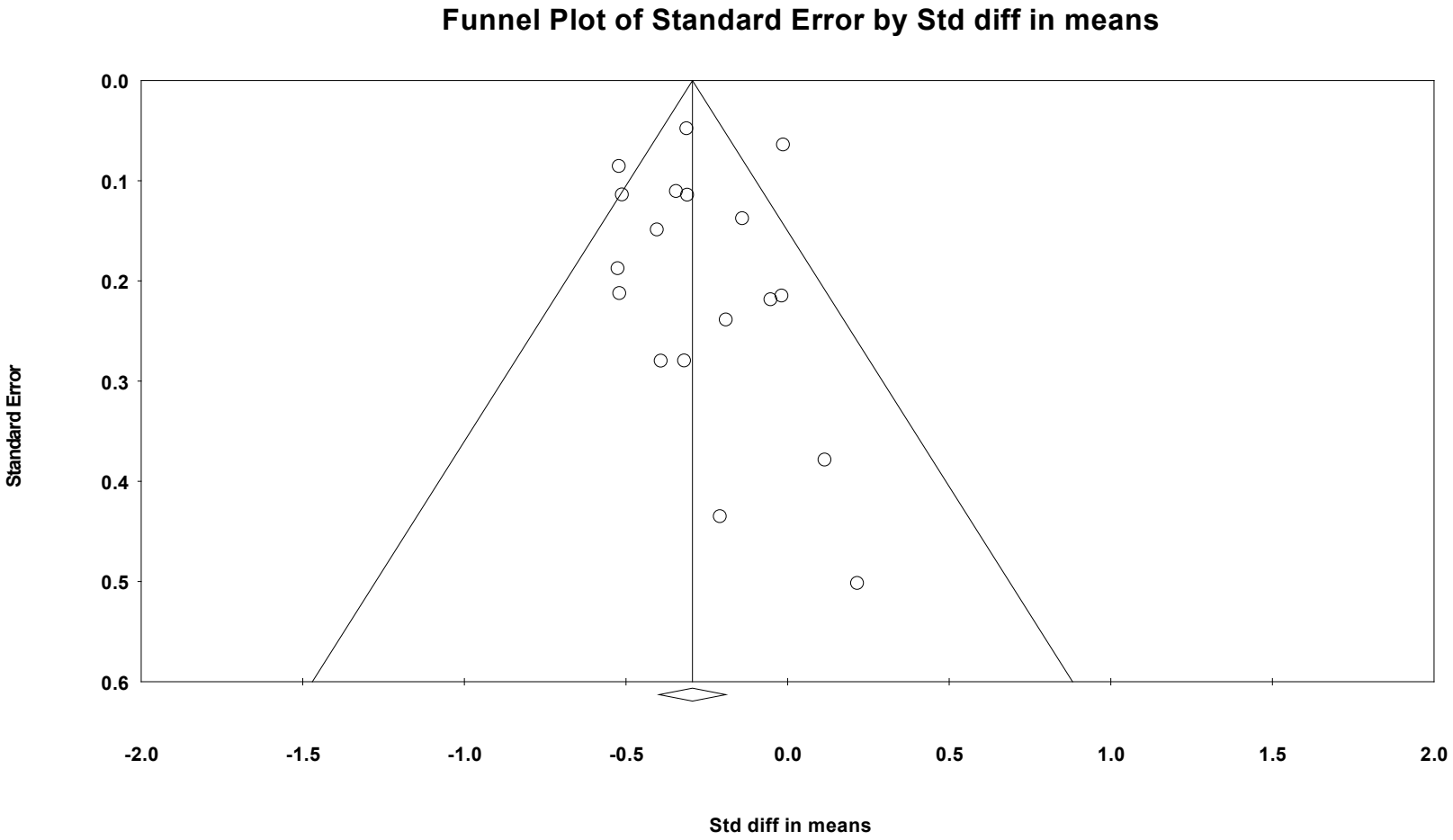
Supplementary Figure 7. The effect of fully automated dCBT-I



Supplementary Figure 8. The effect of dCBT-I on Sleep Outcome Funnel Plot



Supplementary Figure 9. The effect of dCBT-I on Depression Funnel Plot



Supplementary Figure 10. The effect of dCBT-I on Anxiety Funnel Plot