Meta-analysis of digital cognitive behavioral therapy for insomnia

Suonaa Lee

Department of psychiatry

Yonsei university college of medicine

Introduction

- Insomnia can be defined by symptoms such as
  - difficulty in initiating, maintaining sleep, and early-morning awakenings which impair the ability for daily functioning
- Prevalence among adults in general population
  - Insomnia disorder: 10~30%
  - Insomnia symptoms: 33% ~50%
- Bidirectional relationship between insomnia and depression/anxiety
- Cognitive behavioral therapy for insomnia (CBT-I)
  - Sleep restriction, stimulus control, sleep hygiene education, relaxation, and cognitive restructuring
  - First-line treatment for insomnia
  - Considered an effective approach for managing depression and anxiety

Introduction

- Certain limitations of traditional CBT-I
  - Lack of therapists, time and geographical limitations, lack of scalability, high costs

- **Digital CBT-I (dCBT-I)**
  - Reflecting contemporary spectrum of digital technology (e.g., computers, the internet, smartphone applications, and other devices in health care)
  - Effective treatment alternative for insomnia
  - Lack of effectiveness in comparison to the traditional methods of face-to-face CBT-I
  - Adherence remains a critical predictor of treatment outcome

- Further studies are needed to evaluate the outcomes of dCBT-I on insomnia and the comorbid factors depression and anxiety
  - Conducted under controlled conditions
  - Lacking real-world applicability

Introduction

- The present meta-analysis aimed to assess the effects of dCBT-I on depression and anxiety symptoms as well as insomnia and other sleep parameters by pooling published randomized control trials (RCTs).

- A subgroup analysis for the adherence of participants was performed to evaluate the efficacy of dCBT-I.

Methods

- **Systematic Reviews and Meta-Analysis**
- PubMed, Embase, PsycINFO, and Cochrane databases from inception to January 15th, 2022
- **Search strategy**
  - **P**opulation
    - Age ≥ 18
    - Formally diagnosed with *DSM, ICSD, or ICD or having self-reported symptoms of insomnia
    - Reported measures of depressive or anxiety symptoms
  - **I**ntervention: dCBT-I intervention
    - consisted of multimodal components with at least one key cognitive and one key behavioral strategy
  - **C**omparison: active controls, waitlist, treatment as usual (TAU)
  - **O**utcomes
    - self-reported insomnia-related measures and sleep diary outcomes (*TST, SE, WASO, SOL)
    - measures of symptoms of depression and anxiety
  - **S**tudy design: RCTs

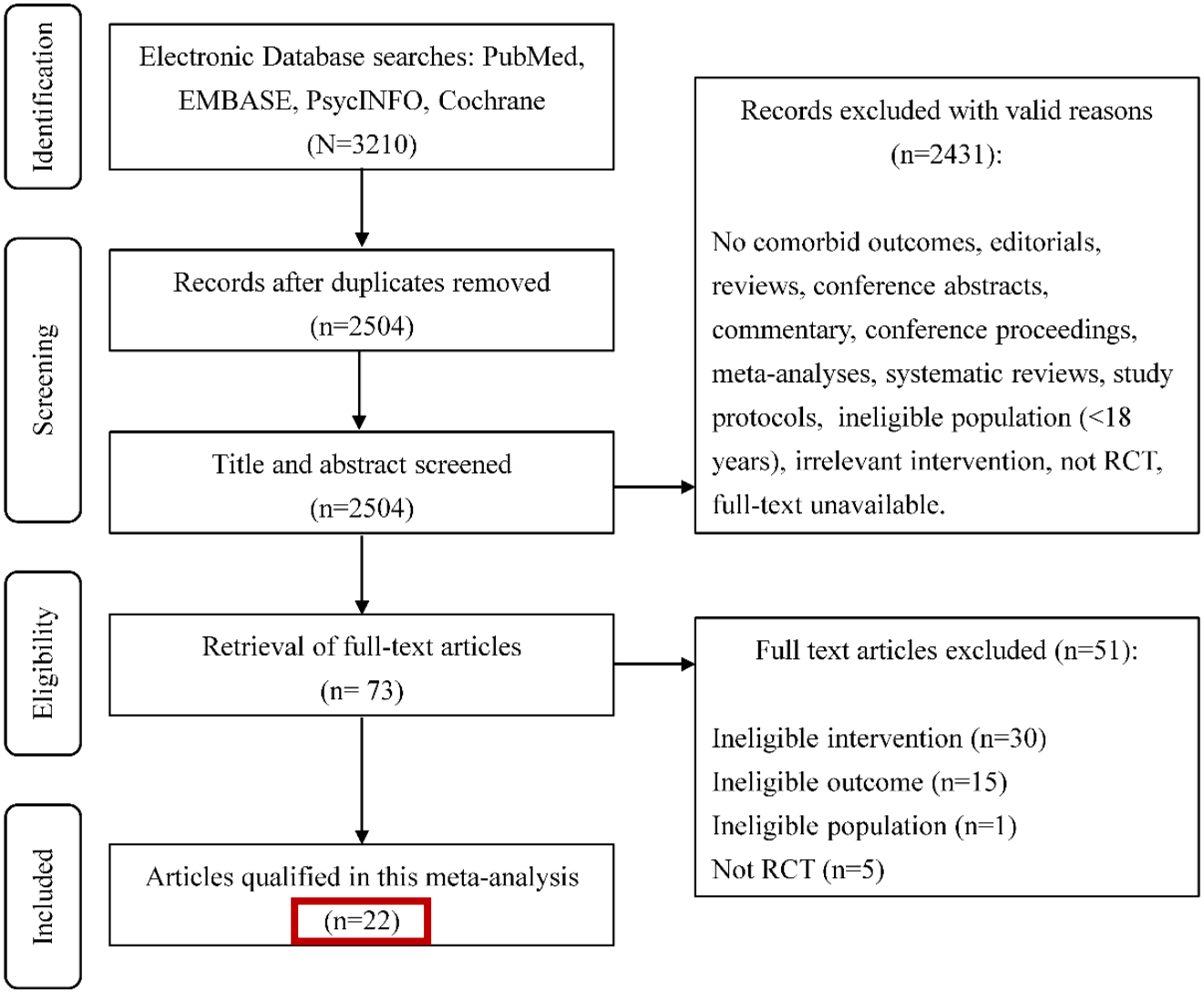
* DSM, Diagnostic and Statistical manual of Mental disorders; ICSD, International Classification of Sleep Disorders; ICD, International Classification of Diseases; SE, Sleep efficiency; SOL, Sleep onset latency; TST, Total sleep time; WASO, Wake after sleep onset

Methods

- **Assessment of risk of bias (RoB)**: The revised Cochrane RoB for RCTs (RoB 2.0)
  - Domains in RoB: randomization process, deviation from intended interventions, missing outcome data, measurement of the outcome, selection of the reported result
- **Data synthesis and analysis**
  - Comprehensive Meta-Analysis (CMA) version 3
  - Treatment efficacy - the standardized mean difference (SMD)
  - Random-effects model
  - Overall between-group SMDs - based on the difference in the post-intervention outcome measures
  - Heterogeneity – Cochrane Q test ($p < 0.05$), I^2 statistics
  - Publication bias – Funnel plot, Egger's test
- **Subgroup analysis**
  - Dividing the groups using dCBT-I completer studies for the adherence of participants
  - Threshold of 65% for completion – based on prior researches (Horsch, C. et al., 2015; Matthews, E. et al., 2013)

Results

- **PRISMA Flow Diagram**



Results

- **Summary of the characteristics of the included studies.**

Author	Year	Country	Total sample size (%Female)	Mean age, years (SD)	Study design	dCBTi components	No. of sessions	Time point of post-assessment	Insomnia outcome measurement	Depression outcome measurement	Anxiety outcome measurement
Agyemang et al.[30]	2017	United States	28 (78.6)	dCBTi: 45 (10.2) TAU: 50 (10.4)	2 parallel arms (dCBTi, TAU)	SRT, SC, CR, SHE	6	9-10 weeks	ISI, TST, SE, SOL WASO	PHQ-9	GAD-7
Ahorsu et al.[31]	2020	Iran	320 (58.4)	dCBTi: 38.37 (13.45) Sleep education: 37.99 (9.88)	2 parallel arms (dCBTi, sleep education)	SHE, RE, CR, SRT, SC	6	10 weeks	ISI, TST, SE, WASO, SOL, PSQI	HADS	HADS
Blom et al.[32]	2015	Sweden	48 (47.9)	dCBTi: 56.1 (10.2) GCBT: 52.6 (16.6)	2 parallel arms (dCBTi, GCBT)	SRT, SC, SHE, CR, RE, RP	8	8 weeks	ISI, TST SE, SOL	MADRS-S	-
Bostock et al.[33]	2016	United Kingdom	270 (33.3)	dCBTi: 33.9 (6.41) WL: 33.3 (5.59)	2 parallel arms (dCBTi, WL)	SRT, SC, CR, RE, SHE	6	8 weeks	SCI	PHQ-2	GAD-2
Cheng et al.[34]	2018	United States	1385 (78.9)	dCBTi: 44.5 (15.8) Online sleep education: 45.7 (15.1)	2 parallel arms (dCBTi, online sleep education)	SRT, SC, CR, PI, RE, SHE	6	12 weeks	ISI	QIDS	-
Christensen et al.[35]	2016	Australia	1149 (73.5)	dCBTi: 42.95 (12.17) Online attention-matched placebo: 42.51 (12.24)	2 parallel arms (dCBTi, online attention-matched placebo)	SRT, SC, CR, SHE, RP	6	6 weeks	ISI	PHQ-9	GAD-7
Espie et al.[36]	2019	United Kingdom	1711 (77.7)	dCBTi: 48.4 (13.9) SHE: 47.7 (13.6)	2 parallel arms (dCBTi, SHE)	SRT, SC, RE, CR, PI, PE, SHE	6	8 weeks	SCI	PHQ-9	GAD-7
Freeman et al.[37]	2017	United Kingdom	3755 (71.3)	dCBTi: 24.8 (7.7) TAU: 24.6 (7.6)	2 parallel arms (dCBTi, TAU)	SRT, SC, RE, CR, PI, SHE, MI, IM	6	10 weeks	ISI	PHQ-9	GAD-7
Felder et al.[38]	2020	United States	208 (100)	dCBTi: 33.90 (3.38) TAU: 33.2 (4.0)	2 parallel arms (dCBTi, TAU)	SRT, SC, CR, RE, SHE	6	10 weeks	ISI, PSQI, SE	EPDS	GAD-7
Glozier et al.[39]	2019	Australia	87 (0)	dCBTi: 58.6 (6.3) Online PE: 58.1 (6.1)	2 parallel arms (dCBTi, Online PE)	SRT, SC, SHE, CR, RP	6	12 weeks	ISI	CES-D	STPI
Kalmbach et al.[40]	2020	United States	91 (100)	dCBTi: 28.91 (28.91) digital sleep education: 29.16 (4.11)	2 parallel arms (dCBTi, digital sleep education)	SRT, SC, CR, PI, RE, SHE	6	7 weeks	ISI, PSQI	EPDS	-
Krieger et al.[41]	2019	Switzerland	104 (68.3)	dCBTi: 42.17 (12.4) SRT: 46.59 (17.52) TAU: 45.24 (12.40)	3 parallel arms (MCT+ TAU, SRT + TAU, TAU)	PE, SRT, RE, CR, SHE, RP	8	8 weeks	ISI, PSQI, SE	ADS-K	-
Kyle et al.[42]	2020	United Kingdom	410 (86.6)	dCBTi: 52.5 (11.2) WL: 52.4 (11.7)	2 parallel arms (dCBTi, WL)	SRT, SC, CR, SHE, RE	6	10 weeks	ISI, PSQI	PHQ-9	GAD-2

Results

- **Summary of the characteristics of the included studies.**

Author	Year	Country	Total sample size (%Female)	Mean age, years (SD)	Study design	dCBTi components	No. of sessions	Time point of post-assessment	Insomnia outcome measurement	Depression outcome measurement	Anxiety outcome measurement
Lancee et al.[43]	2015	Netherlands	63 (79.4)	dCBTi: 47.47 (14.37) WL: 49.98 (13.71)	2 parallel arms (dCBTi, WL)	PE, RE, SRT, SHE, CR	6	12 weeks	ISI, TST, SE, WASO, SOL	CES-D	HADS
Lancee et al.[44]	2016	Netherlands	90 (81.1)	dCBTi: 41.2 (14.1) ftf: 38.5 (13.1) WL: 45.1 (13.7)	3 parallel arms (dCBTi, ftf, WL)	PE, RE, SHE, SRT, CR	6	12 weeks	ISI, TST, SE	CES-D	HADS
Lorenz et al.[45]	2018	Switzerland	56 (69.6)	dCBTi: 41.72 (17.31) WL: 44.04 (20.05)	2 parallel arms (dCBTi, WL)	PE, SRT, SC, RE, SHE, RP, CR	6	6 weeks	ISI, TST, SE, WASO, SOL	BDI-II	BSI-Anxiety
Majd et al.[46]	2020	Iran	312 (55.8)	dCBTi: 36.21 (5.81) Sleep education: 35.29 (5.76)	2 parallel arms (dCBTi, sleep education)	SHE, SC, RE, CR, SRT, PI	6	10 weeks	ISI	HADS	HADS
Pillai et al.[47]	2015	United States	21 (62.5)	dCBTi: 53.2 (12.2) Sleep education: 44.0 (13.2)	2 parallel arms (dCBTi, sleep education)	SRT, SC, CR, PI, RE, SHE	6	7 weeks	ISI, TST, SOL	-	BAI
Sveen et al.[48]	2021	Sweden	21 (66.7)	dCBTi: 49.9 (5.8) Sleep education: 45.6 (5.5)	2 parallel arms (dCBTi, sleep education)	SRT, SC, ST, CR, SHE	8	9 weeks	ISI	MADRS	GAD-7
van der Zweerde et al.[49]	2019	Netherlands	104 (81.7)	dCBTi: 44.64 (13.12) SM: 46.29 (15.07)	2 parallel arms (dCBTi, SM)	SHE, SR, SC, RE, CR, RP	5	9 weeks	ISI, TST, SE, WASO, SOL	PHQ-9	HADS
van der Zweerde et al.[50]	2020	Netherlands	134 (64.9)	dCBTi: 51.7 (15.77) TAU: 49.4 (16.01)	2 parallel arms (dCBTi, TAU)	SHE, SRT, SC, CR, RP, RE	5	8 weeks	ISI, TST, SE, SOL, WASO	HADS	HADS
van Straten et al.[51]	2014	Netherlands	118 (70.3)	dCBTi: 48.7 (13.8) WL: 50.1 (11.9)	2 parallel arms (dCBTi, WL)	PE, SHE, SRT, SC, RE, CR	6	6 weeks	PSQI, TST, SOL, SE	CES-D	HADS

Results

- Total 10,486 participants
  - 5,494 were randomized to the dCBT-I group
  - median study size of 111 participants (range 21-3755)

- The overall mean age
  - dCBT-I group: 43.8 ± 8.7 years
  - Control group: 43.6 ± 8.3 years

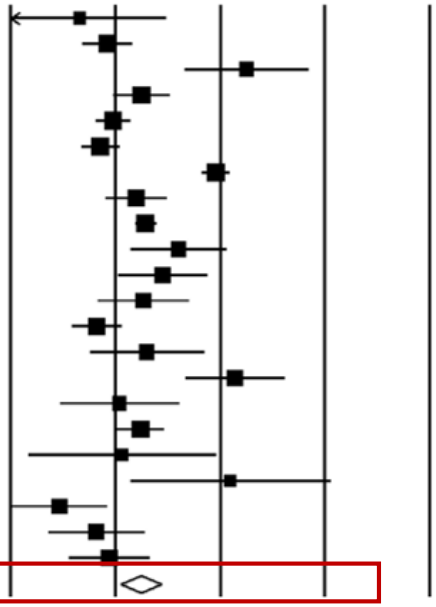
- The average completion rate of dCBT-I sessions: 59.7%

- The overall risk of bias was low for 8 studies, moderate for 10, and high for the remaining 4 studies
  - Studies utilizing self-rating questionnaires as primary outcomes and blinding of participants and research personnel

Results

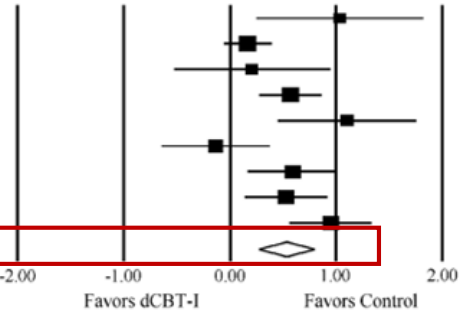
- **The effect of dCBT-I on sleep outcome and sleep efficiency**

Study Name	SMD	SE	Variance	Lower Limit	Upper Limit	z-value	p-value	Sample Size: Intervention	Sample Size: Control	Relative Weight
Sleep Outcome										
Agyemang et al. (2017)	-1.340	0.418	0.175	-2.159	-0.520	-3.203	0.001	14	14	2.84
Ahorsu et al. (2020)	-1.077	0.120	0.014	-1.312	-0.843	-9.003	0.000	160	160	5.39
Blom et al. (2015)	0.255	0.299	0.090	-0.332	0.842	0.851	0.395	22	23	3.80
Bostock et al. (2016)	-0.749	0.142	0.020	-1.027	-0.471	-5.279	0.000	98	116	5.22
Cheng et al. (2019)	-1.021	0.083	0.007	-1.184	-0.858	-12.271	0.000	358	300	5.62
Christensen et al. (2016)	-1.143	0.090	0.008	-1.320	-0.966	-12.650	0.000	248	333	5.58
Espie et al. (2019)	-0.041	0.064	0.004	-0.166	0.084	-0.646	0.518	468	517	5.71
Felder et al. (2020)	-0.799	0.153	0.023	-1.099	-0.500	-5.230	0.000	91	94	5.13
Freeman et al. (2017)	-0.711	0.049	0.002	-0.806	-0.615	-14.583	0.000	733	1142	5.77
Glozier et al. (2019)	-0.395	0.234	0.055	-0.853	0.063	-1.690	0.091	40	35	4.40
Kalmbach et al. (2020)	-0.548	0.215	0.046	-0.969	-0.127	-2.551	0.011	46	44	4.58
Krieger et al. (2019)	-0.729	0.226	0.051	-1.171	-0.286	-3.228	0.001	34	54	4.48
Kyle et al. (2020)	-1.176	0.118	0.014	-1.408	-0.944	-9.927	0.000	155	181	5.40
Lancee et al. (2015)	-0.696	0.278	0.077	-1.241	-0.151	-2.502	0.012	36	22	3.99
Lancee et al. (2016)	0.145	0.238	0.057	-0.322	0.612	0.610	0.542	26	55	4.36
Lorenz et al. (2018)	-0.961	0.293	0.086	-1.536	-0.387	-3.279	0.001	25	27	3.85
Majd et al. (2020)	-0.759	0.117	0.014	-0.988	-0.529	-6.471	0.000	156	156	5.40
Pillai et al. (2015)	-0.936	0.456	0.208	-1.830	-0.043	-2.054	0.040	13	9	2.59
Sveen et al. (2021)	0.100	0.486	0.236	-0.853	1.053	0.206	0.837	9	8	2.41
van der Zweerde et al. (2019)	-1.533	0.237	0.056	-1.998	-1.068	-6.463	0.000	45	47	4.37
van der Zweerde et al. (2020)	-1.181	0.237	0.056	-1.644	-0.717	-4.991	0.000	43	41	4.37
van Straten et al. (2014)	-1.059	0.197	0.039	-1.444	-0.673	-5.385	0.000	59	59	4.75
Overall random effects model	-0.760	0.098	0.010	-0.953	-0.567	-7.722	0.000			



Large effect, I^2 = 90.59; Q = 223.04; df = 21; p < 0.001

Sleep Efficiency										
Agyemang et al. (2017)	1.034	0.402	0.162	0.246	1.823	2.570	0.010	14	14	6.55
Ahorsu et al. (2020)	0.166	0.112	0.013	-0.053	0.386	1.486	0.137	160	160	15.81
Blom et al. (2015)	0.210	0.373	0.139	-0.521	0.941	0.563	0.573	11	21	7.19
Felder et al. (2020)	0.570	0.150	0.023	0.276	0.864	3.800	0.000	91	94	14.45
Lancee et al. (2015)	1.106	0.331	0.110	0.456	1.755	3.337	0.001	25	18	8.23
Lancee et al. (2016)	-0.133	0.261	0.068	-0.645	0.378	-0.511	0.609	21	49	10.36
van der Zweerde et al. (2019)	0.592	0.213	0.045	0.175	1.010	2.780	0.005	45	47	12.06
van der Zweerde et al. (2020)	0.529	0.199	0.040	0.140	0.919	2.663	0.008	55	50	12.59
van Straten et al. (2014)	0.950	0.194	0.038	0.570	1.331	4.893	0.000	59	59	12.77
Overall random effects model	0.528	0.129	0.017	0.275	0.781	4.086	0.000			

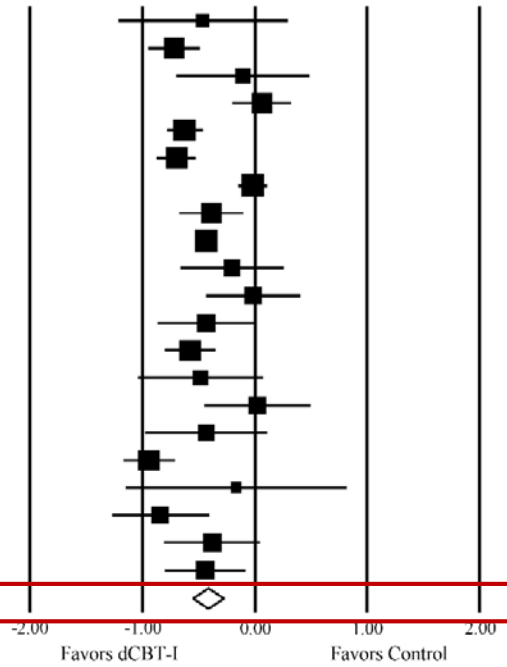


Large effect, I^2 = 68.91; Q =25.73; df =8; p < 0.001

Results

- **The effect of dCBT-I on depression**

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		
Agyemang et al. (2017)	-0.463	0.383	0.147	-1.213	0.288	-1.208	0.227	14	14		2.33
Ahorsu et al. (2020)	-0.719	0.115	0.013	-0.945	-0.493	-6.232	0.000	160	160		6.04
Blom et al. (2015)	-0.107	0.298	0.089	-0.692	0.478	-0.360	0.719	22	23		3.17
Bostock et al. (2016)	0.062	0.137	0.019	-0.207	0.331	0.452	0.651	98	116		5.67
Cheng et al. (2019)	-0.624	0.080	0.006	-0.781	-0.467	-7.786	0.000	358	300		6.59
Christensen et al. (2016)	-0.697	0.086	0.007	-0.866	-0.527	-8.068	0.000	248	333		6.50
Espie et al. (2019)	-0.019	0.064	0.004	-0.144	0.106	-0.292	0.770	468	517		6.80
Felder et al. (2020)	-0.386	0.148	0.022	-0.677	-0.095	-2.601	0.009	91	94		5.47
Freeman et al. (2017)	-0.435	0.048	0.002	-0.529	-0.341	-9.088	0.000	733	1142		6.96
Glozier et al. (2019)	-0.202	0.232	0.054	-0.656	0.253	-0.869	0.385	40	35		4.07
Kalmbach et al. (2020)	-0.012	0.211	0.044	-0.426	0.401	-0.059	0.953	46	44		4.40
Krieger et al. (2019)	-0.432	0.222	0.049	-0.867	0.003	-1.945	0.052	34	53		4.22
Kyle et al. (2020)	-0.574	0.112	0.012	-0.792	-0.355	-5.137	0.000	155	181		6.11
Lancee et al. (2015)	-0.482	0.281	0.079	-1.033	0.068	-1.718	0.086	32	22		3.39
Lancee et al. (2016)	0.023	0.238	0.057	-0.444	0.489	0.095	0.924	26	55		3.98
Lorenz et al. (2018)	-0.431	0.281	0.079	-0.982	0.119	-1.536	0.124	25	27		3.39
Majd et al. (2020)	-0.943	0.119	0.014	-1.177	-0.709	-7.901	0.000	156	156		5.98
Sveen et al. (2021)	-0.166	0.501	0.251	-1.147	0.816	-0.330	0.741	8	8		1.57
van der Zweerde et al. (2019)	-0.839	0.218	0.047	-1.266	-0.413	-3.857	0.000	45	47		4.30
van der Zweerde et al. (2020)	-0.378	0.220	0.048	-0.809	0.054	-1.716	0.086	43	41		4.25
van Straten et al. (2014)	-0.444	0.186	0.035	-0.809	-0.079	-2.382	0.017	59	59		4.81
Overall random effects model	-0.418	0.071	0.005	-0.557	-0.278	-5.878	0.000				

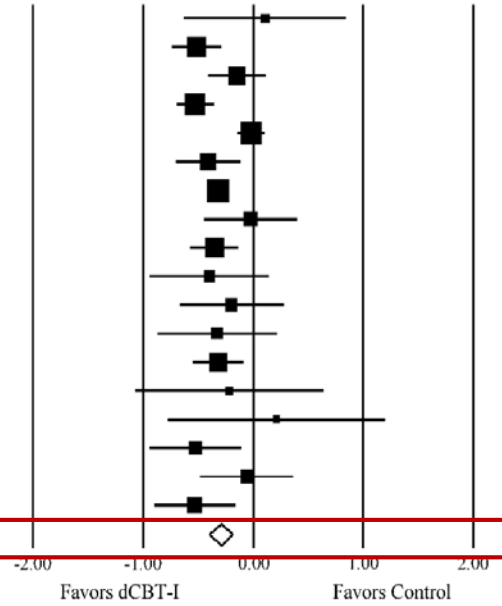


- I^2 = 81.79; Q = 109.85; df = 20; p < 0.001

Results

- **The effect of dCBT-I on anxiety**

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		
Agyemang et al. (2017)	0.114	0.378	0.143	-0.627	0.856	0.302	0.763	14	14		1.68
Ahorsu et al. (2020)	-0.513	0.114	0.013	-0.735	-0.290	-4.512	0.000	160	160		8.06
Bostock et al. (2016)	-0.141	0.137	0.019	-0.410	0.128	-1.025	0.305	98	116		6.87
Christensen et al. (2016)	-0.522	0.085	0.007	-0.690	-0.355	-6.127	0.000	248	333		9.64
Espie et al. (2019)	-0.014	0.064	0.004	-0.139	0.111	-0.224	0.823	468	517		10.85
Felder et al. (2020)	-0.405	0.149	0.022	-0.696	-0.114	-2.724	0.006	91	94		6.36
Freeman et al. (2017)	-0.313	0.048	0.002	-0.407	-0.220	-6.579	0.000	733	1142		11.67
Glozier et al. (2019)	-0.019	0.215	0.046	-0.439	0.402	-0.088	0.930	45	42		4.10
Kyle et al. (2020)	-0.346	0.110	0.012	-0.562	-0.129	-3.134	0.002	155	181		8.24
Lancee et al. (2015)	-0.393	0.280	0.078	-0.941	0.155	-1.405	0.160	32	22		2.78
Lancee et al. (2016)	-0.191	0.238	0.057	-0.659	0.276	-0.803	0.422	26	55		3.53
Lorenz et al. (2018)	-0.320	0.279	0.078	-0.868	0.227	-1.147	0.252	25	27		2.78
Majd et al. (2020)	-0.311	0.114	0.013	-0.534	-0.088	-2.730	0.006	156	156		8.04
Pillai et al. (2015)	-0.210	0.435	0.189	-1.062	0.642	-0.482	0.630	13	9		1.32
Sveen et al. (2021)	0.215	0.501	0.251	-0.768	1.198	0.429	0.668	8	8		1.01
van der Zweerde et al. (2019)	-0.521	0.212	0.045	-0.936	-0.105	-2.456	0.014	45	47		4.17
van der Zweerde et al. (2020)	-0.053	0.218	0.048	-0.481	0.375	-0.243	0.808	43	41		4.01
van Straten et al. (2014)	-0.526	0.187	0.035	-0.893	-0.159	-2.810	0.005	59	59		4.90
Overall random effects model	-0.294	0.053	0.003	-0.397	-0.191	-5.593	0.000				

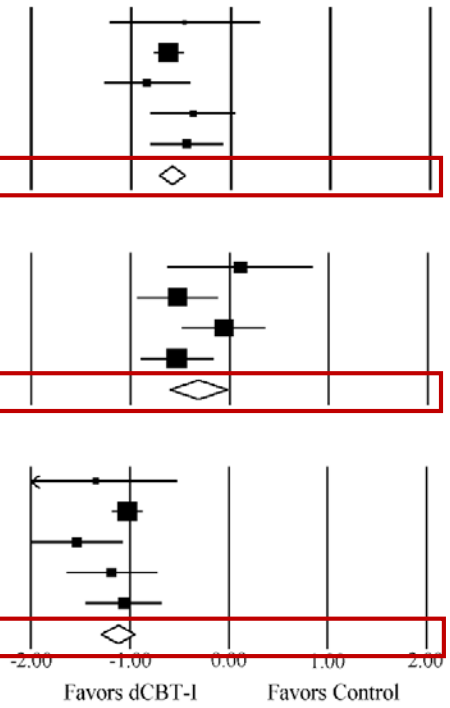


- I^2 = 57.75; Q = 40.24; df = 17; p < 0.001

Results

- **Subgroup analysis- The effect of dCBT-I among dCBT-I completers (>65%)**

Study Name	SMD	SE	Statistics for Each Study: Variance	Lower Limit	Upper Limit	z-value	p-value	Sample Size: 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	2.93
Cheng et al. (2019)	-0.624	0.080	0.006	-0.781	-0.467	-7.786	0.000	358	300	66.81
van der Zweerde et al. (2019)	-0.839	0.218	0.047	-1.266	-0.413	-3.857	0.000	45	47	9.07
van der Zweerde et al. (2020)	-0.378	0.220	0.048	-0.809	0.054	-1.716	0.086	43	41	8.85
van Straten et al. (2014)	-0.444	0.186	0.035	-0.809	-0.079	-2.382	0.017	59	59	12.35
Overall random effects model	-0.595	0.066	0.004	-0.723	-0.466	-9.079	0.000			
Anxiety										
Agyemang et al. (2017)	0.114	0.378	0.143	-0.627	0.856	0.302	0.763	14	14	12.51
van der Zweerde et al. (2019)	-0.521	0.212	0.045	-0.936	-0.105	-2.456	0.014	45	47	28.12
van der Zweerde et al. (2020)	-0.053	0.218	0.048	-0.481	0.375	-0.243	0.808	43	41	27.19
van Straten et al. (2014)	-0.526	0.187	0.035	-0.893	-0.159	-2.810	0.005	59	59	32.17
Overall random effects model	-0.316	0.149	0.022	-0.607	-0.024	-2.124	0.034			
Sleep Outcome										
Agyemang et al. (2017)	-1.340	0.418	0.175	-2.159	-0.520	-3.203	0.001	14	14	4.15
Cheng et al. (2019)	-1.021	0.083	0.007	-1.184	-0.858	-12.271	0.000	358	300	55.28
van der Zweerde et al. (2019)	-1.533	0.237	0.056	-1.998	-1.068	-6.463	0.000	45	47	11.95
van der Zweerde et al. (2020)	-1.181	0.237	0.056	-1.644	-0.717	-4.991	0.000	43	41	12.02
van Straten et al. (2014)	-1.059	0.197	0.039	-1.444	-0.673	-5.385	0.000	59	59	16.60
Overall random effects model	-1.121	0.087	0.008	-1.291	-0.951	-12.917	0.000			



- For the non-adherent group, the treatment effects were also significant but effect sizes were smaller than those in adherent groups for depression (SMD = -0.35; 95% CI: -0.57, -0.14; p = 0.001; I^2 = 88.71; k = 7), anxiety (SMD = -0.28; 95% CI: -0.45, -0.11; p = 0.001; I^2 = 82.34; k = 6), and sleep outcomes (SMD = -0.69; 95% CI: -1.05, -0.34; p < 0.001; I^2 = 95.82; k = 7).

Results

- **Effects of fully automated dCBT-I**
  - Additional subgroup analysis on 15 studies using fully automated version of dCBT-I without support of human therapists
  - The treatment effects were significant for depression (SMD = -0.43; 95% CI: -0.60, -0.27; $p < 0.001$; $I^2 = 87.15$; $k = 14$), anxiety (SMD = -0.29; 95% CI: -0.41, -0.17; $p = 0.001$; $I^2 = 68.46$; $k = 12$), and sleep outcomes (SMD = -0.81; 95% CI: -1.03, -0.59; $p < 0.001$; $I^2 = 92.13$; $k = 15$).

- **Publication bias**
  - Visual inspection of funnel plots and Egger's tests for asymmetry in funnel plots were used to estimate publication bias.
  - The Egger's tests were not significant for depression ($t = 0.03$, $df = 19$, $p = 0.98$), anxiety ($t = 0.02$, $df = 16$, $p = 0.98$), and insomnia ($t = 0.63$, $df = 20$, $p = 0.54$), indicating no significant publication bias.

Discussion

- dCBT-I yielded significant effects at post-treatment on alleviating depressive and anxiety symptoms as well as insomnia symptoms and sleep diary outcomes (SE, TST, SOL, WASO).

- Extending the finding of previous meta-analysis (Ye et al., 2016)
  - Larger sample size (10 → 22 RCTs)
  - Demonstrating effectiveness of fully automated dCBT-I and treatment adherence on improving depression and anxiety

- A study of a fully automated dCBT-I integrated into an existing UK-based clinical service showed effectiveness in alleviating depression, anxiety, and insomnia (Luik et al., 2017).
  - Lack of published studies on the fully automated dCBT-I implementations in real-world environments

Discussion

- In this study, the pooled effects of dCBT-I on depressive and anxiety symptoms is small to moderate, which are possibly due to heterogeneity.
  - the diversity of participants recruited, outcome measures, the delivery format of CBT-I, and baseline severity levels of depression and anxiety

- The majority of the studies had subclinical depression and anxiety samples, suggesting that dCBT-I interventions are beneficial in reducing subclinical depression and anxiety symptoms.

- This study showed the importance of treatment adherence and implications on increasing the treatment efficacy.
  - Investigating factors for improving adherence using digital therapeutics is warranted.

Limitations

- Twelve out of 22 studies had a small sample size of <50.
- Long-term outcomes were difficult to evaluate between studies.
- The baseline severity of depression and anxiety of the participants were not considered.
- The majority of the included studies compared the dCBT-I group with the waitlist, treatment as usual, and psychoeducation, not face-to-face individual CBT-I.

Conclusion

- dCBT-I is effective for patients with depressive and anxiety symptoms, as well as insomnia.

- Future studies are needed to
  - provide the sufficient clinical evidence of effectiveness in the fully automated version in comparison to the traditional methods of face-to-face CBT-I
  - improve our understanding of optimizing adherence using digital tools, regarding the adherence is a potential predictor of treatment effectiveness

YONSEI UNIVERSITY
COLLEGE OF MEDICINE

THANK YOU