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Supplementary Table S1 Essential information about important psychiatric disorders in children and adolescents

Disease	ICD-10	Prevalence	Definition/General characteristics	Probable neurobiological mechanism
Attention deficit hyperactivity disorder	F90.0	2.62%[1]	Lack of persistence in activities that require cognitive involvement, a tendency to move from one activity to another without completing any, and disorganized, ill-regulated, and excessive activity[2]	Dopamine circuits are described as a central factor in the pathogenesis[3]
Autism spectrum disorder	F84.0	0.44%[1]	Persistent impairment in social communication and social interaction; restricted and repetitive patterns of behavior and interests[4]	Autism is a neuropsychiatric developmental syndrome caused by external environmental factors affecting genetically susceptible individuals[5]
Bipolar affective disorder	F31	0.26%[1]	Variations of two patterns of mood: elevated mood and increased energy and activity (hypomania and mania) and lowered mood and decreased energy and activity (depression)[2]	The definitive etiopathology remains unknown. However, an underlying hypothesis is that changes in neuroplasticity, with a decrease in neurotrophic factors, could be associated with the worsening of mood episodes, refractoriness to treatment, cognitive impairment, and functional disability[6]
Depressive disorders	F32-F33	1.32%[1]	The main symptoms are depressed mood and anhedonia. Other symptoms include feelings of worthless or guilt; suicidal ideation, planning or attempts; fatigue or loss of energy; hypersomnia; insomnia; weight or appetite loss or gain; and neurocognitive symptoms[4]	Recent studies suggest inadequate development of the frontolimbic system, with cortical imbalances including high amygdala activity during facial-emotion recognition tasks and greater connectivity between the amygdala and subgenual anterior cingulate cortex[7,8]
Eating disorders	F50	0.15%[1]	Persistent eating disorder or eating-related behavior that results in altered consumption or absorption of food that significantly compromises physical health or psychosocial functioning[4]	Changes in neurotransmitter signalization associated with altered gray and white matter volumes. The gut microbiota is also changed[9]

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Mental retardation	F70-F79	0.2-4%[1]	Impairment of skills that contribute to overall intelligence level (i.e., cognitive, language, motor, and social skills) evident during development[2]	A broad group of heterogeneous conditions that affect brain development and maturation[10]
Obsessive compulsive disorder	F42	3%[1]	Obsessions and/or compulsions[4]	Evidence suggests predominance of the direct excitatory pathway in cortico-striatal-thalamo-cortical circuitry, in addition to involvement of the frontoparietal/frontolimbic networks[11]
Schizophrenia	F20	0.03%[1]	Conditions associated with reality distortion (hallucinations and delusions), disorganized thought and behavior, and a third factor consisting of negative symptoms[4]	Subcortical dopamine dysfunction is considered the key factor in psychotic symptoms[12]
Social anxiety disorder of childhood	F93.2	4.7%[1]	Marked fear or anxiety in social situations in which the individual can be evaluated by others[4]	The amygdala is the main structure involved in etiopathogenesis: hyperactivation leads to an exaggerated fear response[13]
Specific phobia	F40.2	1.8-7.9%[1]	A group of disorders in which anxiety is evoked only, or predominantly, in certain well-defined situations that are not currently dangerous[2]	Evidence from animal studies and human lesions and neuroimaging indicate that the amygdala plays an essential role in innate fear[14]
Tic disorders	F95	0.77%[1]	Involuntary, rapid, recurrent, nonrhythmic motor movement (usually involving circumscribed muscle groups) or vocal production that is of sudden onset and serves no apparent purpose[2]	Altered regulation of neurotransmitters of various brain circuits, especially connections in the premotor cortex and putamen, the ventromedial prefrontal cortex and caudate nucleus, and the limbic system[15]

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Supplementary Box S1 Complete search strategy

Embase	('autism'/exp OR 'autism' OR 'tic' OR 'mental deficiency' OR 'speech disorder' OR 'language disability' OR 'dyslexia' OR 'dyscalculia' OR 'rett syndrome' OR 'asperger syndrome' OR 'attention deficit hyperactivity disorder' OR 'conduct disorder' OR 'separation anxiety' OR 'body dysmorphic disorder' OR 'social phobia' OR 'selective mutism' OR 'adolescent depression' OR 'schizophrenia' OR 'bipolar disorder' OR 'phobia' OR 'mood disorders' OR 'catatonia' OR 'eating disorders' OR 'elimination disorders' OR 'substance use disorders' OR 'oppositional defiant disorders' OR 'personality disorders') AND ('transcranial magnetic stimulation'/exp OR 'transcranial magnetic stimulation' OR 'transcranial electrical stimulation'/exp OR 'transcranial electrical stimulation' OR 'transcranial direct current stimulation'/exp OR 'theta burst stimulation' OR 'transcranial direct current stimulation' OR 'non-invasive brain stimulation' OR 'nibs' OR 'tdcs' OR 'tms'/exp OR 'tms' OR 'tbs') AND ('adolescent'/exp OR 'adolescent' OR 'adolescence'/exp OR 'adolescence' OR 'child'/exp OR 'child' OR 'youth'/exp OR 'youth' OR 'children'/exp OR 'children' OR 'preschool'/exp OR 'preschool') AND ('review'/exp OR review)
PubMed/Psycinfo/ Web of Science/ Cochrane	((Autism Spectrum Disorders) OR (Autistic Spectrum Disorder) OR (Autistic Spectrum Disorders) OR (intellectual disability) OR (mental deficiency) OR (speech disorders) OR (language disorders) OR (language disability) OR (dyslexia) OR (dyscalculia) OR (rett syndrome) OR (asperger syndrome) OR (depression) OR (depressive disorder) OR (bipolar disorder) OR (mood disorders) OR (catatonia) OR (schizophrenia) OR (attention deficit hyperactivity disorder) OR (conduct disorder) OR (oppositional defiant disorder) OR (personality disorders) OR (separation anxiety) OR (social phobia) OR (phobia) OR (body dysmorphic disorder) OR (eating disorders) OR (eliminating disorders) OR (substance use disorders) OR (selective mutism)) AND ((adolescent) OR (adolescence) OR (child) OR (youth) OR (children) OR (preschool)) AND ((TMS) OR (transcranial magnetic stimulation) OR (TES) OR (tDCS) OR (transcranial electrical stimulation) OR (transcranial direct current stimulation) OR (TBS) OR (Theta Burst Stimulation) OR (non-invasive brain stimulation) OR (NIBS)) AND (review)

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Supplementary Table S2 Study characteristics and quality according to AMSTAR-2 criteria

Study	DOI	Disorder	Intervention	Control group	k of clinical trials	Sample size	Mean age (range)	% Women	Ethnicity	AMSTAR-2 quality
Sun et al.[16]	10.3389/fpsyt.2023.1200738	First episode depression	rTMS + antidepressants	Sham stimulation + antidepressant; or antidepressant monotherapy	6	562	15 (12-18)	63.5	NR	Critically low
Cao et al.[17]	10.1016/j.jad.2023.05.051	Depression	rTMS + antidepressants	Sham stimulation + antidepressant	18	1396	NR (08-24)	64.7	NR	Low
Qiu et al.[18]	10.1016/j.jad.2022.09.060	Depression	rTMS + antidepressants	Sham stimulation + antidepressants; or depression scores pre- and post-rTMS (self-controlled)	13	165	NR (10-25)	61.8	NR	High
Sigrist et al.[19]	10.1007/s00787-022-02021-7	Depression	rTMS monotherapy; or + antidepressants; or + antidepressants + psychotherapy; cTBS/iTBS monotherapy; or + antidepressants	Sham stimulation + antidepressants; or depression scores pre- and post-TMS (self-controlled)	10	247	17.45 (12-21)	63.47	NR	Critically low
Brauer et al.[20]	10.1016/bs.pbr.2021.01.013	ADHD	tDCS monotherapy or + ADHD medication	Sham stimulation	13 (8 in children and adolescents)	308 (133 children and adolescents)	(10-17)	NR	NR	Low

ADHD = attention deficit hyperactivity disorder; cTBS = continuous theta burst stimulation; iTBS: intermittent theta burst stimulation; rTMS = repetitive transcranial magnetic stimulation; tDCS = transcranial direct current stimulation.

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Supplementary Table S3 Outcomes of the included studies

Study	Symptom measure	Outcomes assessed	Efficacy	Response rate	Tolerability	Safety
Sun et al.[16]	Depression: HAMD Neurocognitive function: IVA-CPT; THINC-it; MoCA; WCST; TMT; CPT; SCWT; MCCB; CMS	Change in HAMD; response rate; remission rate; change in neurocognitive function scores; dropout rate; incidence of adverse events	Hedge's g=1.50, 95%CI: [1.387, 1.621]; I^2=89%, p<0.00001 Remission rate: RR=1.35, 95%CI [1.03, 1.77]; I^2=0%, p=0.03 4 of 5 studies that assessed neurocognitive function showed improvement after rTMS	RR= 1.35, 95%CI [1.04, 1.76]; I^2=56%, p=0.03)	Dropout RR=0.79, 95%CI [0.32, 1.93]; I^2=0%, p=0.60	Headache: RR=3.07 [0.70, 13.37], I^2=0, p=0.14 Loss of appetite: RR=0.43 [0.07, 2.88], I^2=0, p=0.39 Dizziness: RR=1.30 [0.14, 12.29], I^2=29, p=0.82 Nausea: RR=0.26 [0.03, 2.24], I^2 0, p=0.22
Cao et al.[17]	Depression: HAMD, BDI	Change in HAMD/BDI; response rate; dropout rate; incidence of adverse events	Two weeks post-treatment: Hedge's g=4.63, 95%CI: [4.57, 4.68]; I^2=91%; P<0.05 Four weeks post-treatment: Hedge's g=2.48, 95%CI: [2.36, 2.59]; I^2=98%; P<0.05	OR=3.99, 95%CI [2.73, 5.85]; P<0.05	Same dropout rate in active and sham stimulation groups	Adverse events: OR=0.64, 95%CI: [0.20, 2.04]; I^2=64%;
Qiu et al.[18]	Depression: HAMD, CDRS-R	Change in HAM-D/CDRS-R; remission rate; response rate; dropout rate; description of adverse events	Hedge's g=1.36, 95%CI [0.85, 1.88]; I^2=99.40%; P<0.001. Remission rates varied from 13 to 44%	Response rates range from 33% to 56%	Dropout rate = 0.04, 95%CI [0.02, 0.09]; I^2=0; P=1	Adverse events rates could not be obtained, but no severe adverse events were described.
Sigrist et al.[19]	Depression: HDRS, BDI-II, CDRS-R	Change in HDRS/CDRS-R/BDI-II; response rate	Hedge's g pre and post treatment in: - All studies: 2.03, 95%CI [1.45, 2.60], SE=0.29, p<0.001 - Only L-DLPFC HF-TMS studies: 1.98, 95%CI [1.25, 2.70], SE=0.37, p<0.001	Transformed Proportion in: - All studies: 0.41 (41.30%), 95%CI [0.31; 0.52], SE=0.05; p<0.001)	NR	NR

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			- Only HF-TMS studies: 0.46 (45.52%), 95%CI [0.36; 0.55], SE=0.05, p<0.001)			
Brauer et al.[20]	ASRS, DISYPS, Qb test, CPT, MOXO-CPT, KiTAP, N-back, Eriksen Flanker task, SST, Go/No Go, Digit Span	Change in symptoms measures; incidence of adverse events	Overall symptom severity in: - All studies: Hedge's g=0.23, 95%CI [0.05, 0.41], P=0.012 - Only children: Hedge's g=0.36, 95%CI [0.06, 0.66], P=0.018	NR	NR	Itching: RR= 0.87, 95%CI [0.48, 1.56], P= 0.634 Tingling: RR= 0.679, 95%CI [0.33, 1.4], P= 0.297 Headache: RR= 0.84, 95%CI [0.14, 5.07], P= 0.847 No severe adverse event was described

ABC = Aberrant Behavior Checklist Hyperactivity, Irritability, and Lethargy/Social Withdrawal; ASRS = Adult ADHD Self-Report Scale; BDI = Beck Depression Inventory; CDRS-R = Children's Depression Rating Scale–Revised (CDRS-R); CMS = Clinical Memory Scale; CPT = continuous performance test; DISYPS = Diagnostic System of Mental Disorders in Children and Adolescents; HAMD = Hamilton Depression Scale; HF-TMS = high-frequency transcranial magnetic stimulation; IVA-CPT = Integrated Visual and Auditory Continuous Performance Test; KiTap = Test of Attentional Performance for Children; MCCB = MATRICS Consensus Cognitive Battery; MoCA = Montreal Cognitive Assessment; MT = motor threshold; NR = not reported; OR = odds ratio; Qb test = quantified behavior test; RBS-R = Repetitive Behavior Scale-Revised Compulsive Behavior, Ritualistic/Sameness Behavior, Stereotypic Behavior, and Total; RR = risk ratio; SCWT = Stroop Word-Color Interference Test; SDS = Sheehan Disability Scale; SST = Stop Signal Task; TMT = Trail Making Test; WCST = Wisconsin Card Sorting Task; WSCT = Wisconsin Card Sorting Test.

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Supplementary Table S4 TMS and tDCS parameters of the included studies

Study	Cortical target	Frequency in Hz	Intensity in mA or %RMT	Pulses per session; Number of sessions; Total pulses	Number of trains per day; Session duration in minutes; Seconds/train; Seconds/interval	Treatment frequency/week Treatment duration in weeks Follow up period in weeks
Sun et al.[16]	L-DLPFC R-DLPFC	1 or 10	80-100%	1200-2400 10-30 NR	30-60 NR 1-5 15-28	NR 2-6 NR
Cao et al.[17]	R-DLPFC L-DLPFC	1 or 10	80-120%	600-2400 NR NR	NR NR NR NR	NR 2-6 NR
Qiu et al.[18]	L-DLPFC Bi-DLPFC	10	80-120%	NR 10-30 24000-90000	NR NR NR NR	NR 2-8 4-144
Sigrist et al.[19]	L-DLPFC R-DLPFC Bi-DLPFC	1 or 10 Hz (TMS); 50 Hz (TBS)	80-120%	900-6000 7-30 NR	NR 15-37,5 2-5 12-58	NR NR NR

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Brauer et al.[20]	L-DLPFC R-DLPFC Bi-DLPFC R-IFG	NR	0.25-2	NR 1-10 NR	NR 15-30 NR NR	NR NR 3 days - 4 weeks

Bi-DLPFC = bilateral dorsolateral prefrontal cortex; L-DPFC = left DLPFC; NR = not reported; R-DLPFC = right DLPFC; R-IFC = right inferior frontal cortex; R-IFG = right inferior frontal gyrus; R-SOA = right supraorbital area.

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