

Supplementary Table 1. Overview of selected brain-age prediction studies in children and adolescents.

Authors	Title	Age Range (Training)	Age Range (Testing)	Cohort (Training)	Cohort (Testing)	Model Performance (reported in MAE of years unless otherwise specified)	r/R^2	Features	Model Type Used	Outcome
Ball et al., 2017	Modelling neuroanatomical variation during childhood	3-21	5-21	PING	ABIDE	1.54; 1.65 (ABIDE)	–	Brain tissue volume, cortical thickness, area	Neighborhood preserving embedding	–
Ball et al., 2021	Individual variation underlying brain age estimates in children	3-21	3-21	PING	PING	1.81, 1.75, 1.92	R^2 = 0.79, 0.81, 0.78	Cortical thickness, area	regularised linear regression	cognition
Beck et al., 2024	Dimensions of early life adversity are differentially associated with brain age	8.9-13	8.9-13	ABCD	ABCD	MAE: 0.79 (T1), 0.71 (DTI), 0.89 (T2)	R^2: 0.34 (T1), 0.43 (DTI), 0.17 (T2)	T1 (cortical surface area, thickness), T2 (white matter volume)	XGBoost	trauma/adversity
Brouwer et al., 2021	The Speed of Development of Adolescent Brain Age	9-23	9-23	BrainSCALE	BrainSCALE	1.24 (GMD model), others available	R^2 = 0.77	(1) a voxel-based GMD feature, (2) a set of brain age predictors	SVR (support vector regression)	genetics, sex differences
Brown et al., 2012	Neuroanatomical Assessment of Biological Maturity	3-20	3-20	PING	PING	1.71 (T1), 1.71 (DTI), 1.6 (T2)	R^2: 0.828 (T1), 0.806 (DTI), 0.806 (T2)	Cortical thickness and area	regularized multivariate nonlinear regression	–
Cao et al., 2015	Development and validation of a brain maturation index	4-18	6-17	NIH Pediatric MRI Data Repository	NIH Pediatric MRI Data Repository	1st timepoint: 1.69, 2nd timepoint: 1.69, 1.41 (external, NAPLS2)	1st timepoint: R: 0.82, 2nd timepoint: R: 0.84 (PING), 0.51 (NAPLS2)	Cortical & subcortical volume	LASSO	–
Chung et al., 2018	Use of Machine Learning to Determine Deviance in Brain Age	12-21	12-21	PING	North American Prodrome Longitudinal Study	1.69, 1.41 (external, NAPLS2)	R^2: 0.84 (PING), 0.51 (NAPLS2)	Cortical volume, subcortical volume	Ridge regression	psychosis
Cohen et al., 2024	Relative Brain Age Is Associated with Socioeconomic Status	5-18	5-18	HBN	HBN	1.41 (may refer to original model)	R^2 = 0.71 (may refer to original model)	Cortical mean curvature, white matter volume	JIVE, Ridge regression	SES, anxiety, depression
Cropley et al., 2021	Brain-Predicted Age Associates With Psychopathology	8-21	8-21	PNC	PNC	1.49, 1.61 (non-typically developing)	r = 0.82 (TD), 0.72 (non-TD)	Cortical volume, area, thickness	SVR (support vector regression)	ADHD
Dehestani et al., 2023	Developmental brain changes during puberty and adolescence	8-21	9-13	ABCD, (HCP for supplement)	ABCD	7.5 months	r = 0.47	Cortical volume, area, thickness	SVR (support vector regression)	puberty, mental health
de Noij et al., 2020	Longitudinal trajectories of brain age in young individuals	15-28	15-30	Scottish Bipolar Family Study	Scottish Bipolar Family Study	2.21	r = 0.4	smoothed modular grey matter volume	RVR (relevance vector regression)	mental health
Drobonin et al., 2022	The Developmental Brain Age Is Associated With Adversity	9-19	9-19	ABIDE, ABIDE-II, CMI, CC FORBOW	ABIDE, ABIDE-II, CMI, CC FORBOW	1.53; 1.55/1.98 bias-corrected (value)	–	Cortical volume, surface area	XGBoost	depression, functional impairment, environmental adversity
Erus et al., 2015	Imaging Patterns of Brain Development and their Relation to Age	8-22	8-22	PNC	PNC	1.22	r = 0.89	Gray (GM) and white (WM) volume	SVR (support vector regression)	cognition
Frankle et al., 2012	Brain maturation: Predicting individual Brain Age in children	5-18	5-18	Pediatric MRI Data Repository	Pediatric MRI Data Repository	1.1	r = 0.93	GM, WM, and CSF	RVR (relevance vector regression)	preterm birth
Gotlib et al., 2022	Effects of the COVID-19 Pandemic on Mental Health in Adolescents	18-75	13-17	ENIGMA	In-study sample	–	–	Cortical thickness and surface	Ridge regression	covid-related cohort differences
Gottschewsky et al., 2024	Menarche, pubertal timing and the brain: female-specific brain age	15.25 ± 3.6	11.91 ± 0.6	PNC	ABCD	MAE: 1.1, RMSE: 1.3	–	Cortical volume, area, thickness	XGBoost	menarche status, puberty
Hedderich et al., 2021	Increased Brain Age Gap Estimate (BrainAGE) in Youth	11-70	25-28	ICCON, NIH, IXI, C-MIND	Bavarian Longitudinal Study	MAE and RMSE not reported (reference)	–	GM, WM, and CSF	RVR (relevance vector regression)	cognition, perinatal variables, prematurity
Holm et al., 2023	Linking brain maturation and puberty during early adolescence	5-93	9-13	21 publicly available datasets	ABCD	.7, 1.4 (baseline, follow-up)	–	T1-weighted data	CNN (convolutional neural network)	puberty
Karolis et al., 2017	Volumetric grey matter alterations in adolescents and young adults	9-65	Adolescent	ABIDE, COBRE, OASIS, IXI	In-study sample	–	r = 0.81, 0.42 and 0.81	GMVs, Lis, GMVs & Lis	G LASSO	premature birth
Keding et al., 2021	Differential Patterns of Delayed Emotion Circuit Maturation	8-18	8-18	In-study sample	In-study sample	1.66 (whole-brain), 1.602 (emotion)	r = 0.677 (whole-brain), 0.663 (emotion)	Cortical and subcortical volume	stacked generalization	internalizing behavior
Keding et al., 2024	Diverging Effects of Violence Exposure and Psychiatric Symptoms	8-24	8-24	PNC	PNC	MAE provided separately for each R^2 provided separately for each R^2	–	rsfMRI	CNN (convolutional neural network)	violence exposure, internalizing, externalizing
Kelly et al., 2022	Investigating brain structural maturation in children and adolescents	3-21	7, 13	PING	Victorian Infant Brain Study	1.72 (PING), 1.92; 1.53 (VIBES), 7	r = 0.9 (PING)	Cortical volume, area, thickness	Gaussian process regression	preterm birth
Khundrakpam et al., 2015	Prediction of brain maturity based on cortical thickness	12.9 ± 3.8	12.9 ± 3.8	Pediatric MRI Data Repository	Pediatric MRI Data Repository	1.95, 1.79, 1.74, 1.71, 1.68 (difference)	r = 0.78, 0.81, 0.82, 0.83, 0.84	Cortical thickness	linear regression (elastic net)	cognition
Kurth et al., 2022	Preliminary evidence for a lower brain age in children	5-22	6-18	Pediatric MRI Data Repository	In-study sample	–	–	Processed gray matter volume	RVR (relevance vector regression)	ADHD
Lewis et al., 2018	T1 white/gray contrast as a predictor of chronological age	3-22	3-22	NIHPD, PING	NIHPD, PING	MAE: 1.52 (contract + thickness), 1.18, 0.26 (age-harmonized)	r = 0.92 (contrast + thickness)	T1 white/gray contrast, cortical thickness	linear regression (elastic net)	cognition
Luna et al., 2021	Maturity of gray matter structures and white matter connectivity	5-21	5-21	HBN	HBN (Healthy Brain Network)	1.18, 0.26 (age-harmonized)	–	Thickness, volume, area, rsfMRI	ensemble, SEMI was best	mental health, cognition
Lund et al., 2022	Brain age prediction using fMRI network coupling in youth	8-22	8-22	PNC	HBN (Healthy Brain Network)	PNC: 2.43 MAE, 2.93 RMSE. HBN: 1.18, 0.26 (age-harmonized)	r = 0.6 (PNC), 0.54 (HBN)	rsfMRI	SLM (shrinkage estimation of model)	mental health
MacSweeney et al., 2024	Multimodal brain age indicators of internalising problems	9-13	9-13	ABCD	ABCD	Same as Beck et al., 2024	–	Same as Beck et al., 2024	XGBoost	internalizing symptoms
Mareckova et al., 2023	Longitudinal study of epigenetic aging and its relations to brain age	6-89	Adolescent	ABIDE, CoRR, DLBS and ENIGMA	VULDE	–	–	Cortical thickness	RVR, gaussian process	epigenetic age
Ng et al., 2024	Frontoparietal and salience network synchronizations in adolescents	7-30	7-30	In-study sample	In-study sample	MAE: 2.94, RMSE: 4.15	R^2 = .519	Task-based fMRI network	Gradient Boosting	math performance
Nielsen et al., 2019	Evaluating the Prediction of Brain Maturity From Functional MRI	7-31	7-31	In-study sample	In-study sample	–	R^2: 0.57	rsfMRI	SVM	motion
Niu et al., 2022	Multidimensional brain-age prediction reveals altered brain maturation	14.41 ± 3.6	Healthy cohort	PNC	PNC	1.751 to 3.16 (5 sex-specific models)	R^2: 0.131 to 0.798 (5 sex-specific models)	Grey matter volume, FA	Ridge regression	Specific phobia, social phobia, depression, PTSD, ODD, ADHD
Rakesh et al., 2021	Neighborhood disadvantage and longitudinal brain-age prediction	8-21	12, 16, 19	PNC	OADS (Orygen Adolescent Study)	Training (PNC): 1.43, Testing (OA Training): 1.43	r = 0.79, Testin	Cortical volume, area, thickness	SVR (support vector regression)	neighborhood disadvantage, parenting, effortful control
Ray et al., 2024	Adolescent brain maturation associated with environmental factors	8-22	9-10	PNC, ABCD	ABCD	0.49	–	Grey matter density (ICA contrast)	SVR (support vector regression)	cognition, and a set of environmental variables: air pollution, population density, area crime, neighborhood safety, school safety
Rudolph et al., 2017	At risk of being risky: The relationship between "brain age" and risk-taking	10-25	10-25	–	–	Training RMSE: 1.503, Test RMSE: 1.503	R^2: 0.81, test R^2: 0.42	pseudo-rsfMRI, cortical thickness	PLSR (partial least squares regression)	risk perception and preference
Sanders et al., 2024 (preprint)	Associations between methylation age and brain age in children	18-75	18-24	ALSPAC (Avon Longitudinal Study of Parents and Children)	ALSPAC (Avon Longitudinal Study of Parents and Children)	4.3	r = 0.27	Cortical thickness and surface	Ridge regression	methylation, physical, cognitive and mental health
Soehner et al., 2023	Naturalistic Sleep Patterns are Linked to Global Brain Age	18-92	9-25	brainageR; 7 cohorts: AIBI, NAPS (Neuroimaging and Psychiatric Study), etc.	9.933	1.33 (grey matter); 0.97 (white matter)	r = 0.81 (grey matter); 0.91 (white matter)	PCA from GM, WM, and C	Gaussian process regression	sleep
Stratton et al., 2024	Transient patterns of advanced brain ageing in female adolescents	12-23	12-23	NIH MRI Study of Normal Development	In-study sample	sNMI: 1.67 (PNC), 1.59 (PING); fMRI: 1.67 (PNC), 1.59 (PING)	r = 0.822 (PNC), 0.872 (PING)	Grey matter volume, white matter volume	SVR (support vector regression)	Anorexia nervosa (multiple clinical measures)
Truelove-Hill et al., 2020	A Multidimensional Neural Maturation Index Reveals Brain Age	8-21	8-21, 16-21	PNC	PING, multisite schizophrenia	–	r = 0.88 (training sample), r = 0.81 (validation)	Grey matter volume, white matter volume	SVR (support vector regression)	schizophrenia
Tung et al., 2019	Deviation from normative brain development is associated with brain age	6-25	6-25	In-study sample	In-study sample	–	–	Cortical volume, area, thickness	SVR (support vector regression)	autism symptoms
Ullman et al., 2017	Timing of White Matter Development Determines Cognitive Function	6-20	6.8 ± 0.3	In-study sample	In-study sample	–	r = 0.81	FA	SVR (support vector regression)	Cognition
Wang et al., 2021	Predicting brain age during typical and atypical development	8-23	5-30	PNC	Functional Connectome Project	1.1 to 1.47 (2 sex-specific models)	r = 0.74 to 0.9 (2 sex-specific models)	Grey matter volume, white matter volume	Partial least square regression	ASD
Whitmore et al., 2023	BrainAGE as a measure of maturation during early adolescence	9-19; 9-11	9-14	Same as Drobonin et al., 2022	ABCD	Existing model: 2.32 (uncorrected)	–	Cortical volume and area, thickness	XGBoost	puberty, cognition
Wierenga et al., 2019	Sex Effects on Development of Brain Structure and Function	8-26	8-26	BrainTime	BrainTime	2.015	0.79 (adjusted R^2)	Cortical surface area & thickness	Random forest	cognition, sex differences
Zhao et al., 2019	Brain age prediction: Cortical and subcortical shape and volume	5-18	6-18	HBN	NKI-RS	1.41	R^2 = 0.71	Covariance: cortical mean	Ridge regression	IQ, sex
Zhao et al., 2023	Differential effects of generalized anxiety and separation anxiety on brain age	5-18	Average at HBN (CBIC site)	HBN (RUBIC site)	1.97 (discovery), 1.81 (validation)	r = 0.678 (discovery), 0.734 (validation)	va	Cortical thickness, surface	SVR (support vector regression)	anxiety

Families Overcoming Risks and Building Opportunities for Well-being, HBN: Healthy Brain Network, IXI: Information eXtraction from Images, NKI-RS: Nathan Kline Institute - Rockland Sample, OASIS: Open Access Series of Imaging Studies, PING: Pediatric Imaging, Neurocognition, and Genetics, PNC: Philadelphia Neurodevelopmental Cohort, VULDE: