Supplementary Table 1 – Search strategy

Table 1: Summary of search strategies including MESH terms, text words and combinations used in MEDLINE, Embase, and PsycINFO searches (via OvidSP)

Keyword	MEDLINE	Embase	PsycINFO
Population = Children and/or adolescents	Exp Child/ OR Child$.tw OR Girl$.tw OR Boy$.tw or P?ediatric$.tw OR Exp Pediatrics/ OR Adolescent/ OR Adolescen$.tw OR Teen$.tw OR Youth$.tw OR Young Adult/ OR Young adult.tw	Exp Child/ OR Child$.tw OR Girl$.tw OR Boy$.tw OR P?ediatric$.tw OR Exp pediatrics/ OR Exp Adolescent/ OR Adolescen$.tw OR Teen$.tw OR Youth$.tw OR Exp young adult/ OR Young adult.tw	Exp Pediatrics/ OR Exp Childhood Development/ OR Exp Adolescent Development/ OR Child$.tw OR Girl$.tw OR Boy$.tw OR P?ediatric$.tw OR Adolescen$.tw OR Teen$.tw OR Youth$.tw OR Young adult.tw
Exposure = CKD[1] (mild-to-moderate stage CKD, dialysis, and kidney transplantation)	Exp Kidney Diseases/ OR (kidney adj3 (insuffic$ or diseas$)).tw OR (renal adj3 (insuffic$ or diseas$)).tw (pre-dialysis or predialysis).tw OR exp Renal Replacement Therapy/ OR H?emodialysis.tw OR (hemofiltration or haemofiltration).tw OR (hemodiafiltration or haemodiafiltration).tw OR dialysis.tw OR (PD or CAPD or CCPD or APD).tw OR peritoneal dialysis.tw (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw OR (ESRF or ESKF or ESRD or ESKD).tw OR (chronic kidney or chronic renal).tw OR (CKF or CKD or CRF or CRD).tw OR ur?emi$.tw OR Kidney Transplantation/ OR (dysfunction	Exp kidney disease/ OR (kidney adj3 (insuffic$ or diseas$)).tw OR (renal adj3 (insuffic$ or diseas$)).tw OR (pre-dialysis or predialysis).tw OR exp renal replacement therapy/ OR (hemodialysis or haemodialysis).tw OR (hemofiltration or haemofiltration).tw OR (hemodiafiltration or haemodiafiltration).tw OR dialysis.tw OR (PD or CAPD or CCPD or APD).tw OR peritoneal dialysis.tw OR (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw OR (ESRF or ESKF or ESRD or ESKD).tw OR (chronic kidney or chronic renal).tw OR (CKF or CKD or CRF or CRD).tw OR ur?emi$.tw OR exp kidney	Exp Kidney Diseases/ OR exp Kidneys/ OR exp Organ OR Transplantation/ or exp Dialysis/ OR (kidney adj3 (insuffic$ or diseas$)).tw OR (renal adj3 (insuffic$ or diseas$)).tw OR (pre-dialysis or predialysis).tw OR (hemodialysis or haemodialysis).tw OR (hemofiltration or haemofiltration).tw OR (hemodiafiltration or haemodiafiltration).tw OR dialysis.tw OR (PD or CAPD or CCPD or APD).tw OR peritoneal dialysis.tw OR (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw OR (ESRF or ESKF or ESRD or ESKD).tw OR (chronic kidney or chronic renal).tw OR (CKF or CKD or CRF or CRD).tw OR ur?emi$.tw OR (dysfunction adj3 (kidney or renal)).tw OR nephrotic syndrome.tw

Keyword	MEDLINE	Embase	PsycINFO
	adj3 (kidney or renal)).tw OR exp Nephrotic Syndrome/ OR nephrotic syndrome.tw OR exp Nephrosis, Lipoid/ OR lipoid nephrosis.tw	transplantation/ OR (dysfunction adj3 (kidney or renal)).tw OR exp nephrotic syndrome/ OR nephrotic syndrome.tw OR exp lipoid nephrosis/ OR lipoid nephrosis.tw	
Methodology = Observational studies, inclusive of case-control, cross-sectional and cohort studies	Exp Epidemiologic Studies/ OR Case control.tw OR (cohort adj (study or studies)).tw OR Cohort analy$.tw OR (follow up adj (study or studies)).tw OR (observational adj (study or studies)).tw OR Longitudinal.tw OR Retrospective.tw OR Cross sectional.tw OR exp Meta-Analysis/ OR Meta anal$.tw OR Metaanaly$.tw OR (systematic adj (review$1 or overview$1)).tw	Exp epidemiology/ OR Case control.tw OR (cohort adj (study or studies)).tw OR Cohort analy$.tw OR (follow up adj (study or studies)).tw OR (observational adj (study or studies)).tw OR Longitudinal.tw OR Retrospective.tw OR Cross sectional.tw OR Exp meta-analysis/ OR Meta anal$.tw OR Metaanaly$.tw OR (systematic adj (review$1 or overview$1)).tw	Exp Epidemiology/ OR Case control.tw OR (cohort adj (study or studies)).tw OR Cohort analy$.tw OR (follow up adj (study or studies)).tw OR (observational adj (study or studies)).tw OR Longitudinal.tw OR Retrospective.tw OR Cross sectional.tw OR Exp Meta Analysis/ OR Exp "Literature Review"/ OR Meta anal$.tw OR Metaanaly$.tw OR (systematic adj (review$1 or overview$1)).tw
Comparator = None	No search strategy	No search strategy	No search strategy
Outcome = All neurocognitive domains	Exp Emotional Intelligence/ OR exp Intelligence Tests/ OR exp Intelligence/ OR Intell$.tw OR Academic.tw OR Educatio$.tw OR exp Education/ OR IQ.tw OR exp Cognition OR Cogniti$.tw OR (outcome adj3 (education$ or academic or cogniti$ or psychological or neurocognit$)).tw OR (intell$ adj3 (quotient or def$ or abilit$)).tw OR exp Neuropsychological Tests/ OR (Wechsler adj3 (intelligen$ or	Exp intelligence/ OR exp emotional intelligence/ OR exp intelligence test/ OR Intell$.tw OR Academic.tw OR Educatio$.tw OR exp education/ OR IQ.tw OR exp cognition assessment/ OR exp cognition/ OR Cogniti$.tw OR (outcome adj3 (education$ or academic or cogniti$ or neurocognit$)).tw OR (intell$ adj3 (quotient or def$ or abilit$)).tw OR exp neuropsychological test/ OR (Wechsler adj3 (intelligen$ or	Exp Emotional Intelligence/ OR exp Intelligence Quotient/ OR exp Cognitive Ability/ OR exp Intelligence Measures/ OR exp Intelligence/ OR exp Academic Aptitude/ OR exp Academic Achievement/ OR exp Academic Failure/ OR exp Psychological Assessment/ OR exp Cognition/ OR exp Psychological Development/ OR exp Cognitive Impairment/ OR exp Cognitive Processes/ OR exp Performance Tests/ OR exp Attention/ OR exp Executive Function/ OR exp Memory/ OR exp Verbal Fluency/

Keyword	MEDLINE	Embase	PsycINFO
	memory)).tw OR (neuropsychiatric adj3 (inventory or battery)).tw OR exp Executive function/ OR exp Memory/ OR exp Language/ OR exp Attention/ OR exp Language/ OR exp language tests/ OR exp Visual perception/ OR exp Space perception/ OR Psychomotor performance.tw OR Global cognitive function$.tw OR (memory adj3 (disorder$ or function$ or def$)).tw OR (Speed adj1 (processing or response)).tw OR (visuospatial adj1 (perception or function)).tw OR Verbal fluency.tw OR (flexibility adj1 (cognitive or mental)).tw OR exp "Inhibition (Psychology)"/ OR exp Problem Solving/ OR Social cognition.tw OR (Set adj1 (switching or shifting)).tw OR exp Mathematics/ OR exp discrimination learning/ OR exp verbal learning/ OR (neurocognit$ adj3 (function$ or defic$ or abnormal$ or outcome$ or disorder$ or illness$ or problem$ or wellbeing or well-being or health or stress)).tw	memory)).tw OR (neuropsychiatric adj3 (inventory or battery)).tw OR Neuropsychological test$.tw OR exp executive function/ OR exp memory/ OR exp language/ OR exp attention/ OR exp language test/ OR exp depth perception/ OR Psychomotor performance.tw OR Global cognitive function$.tw OR (memory adj3 (disorder$ or function$ or def$)).tw OR (Speed adj1 (processing or response)).tw OR (visuospatial adj1 (perception or function)).tw OR Verbal fluency.tw OR (flexibility adj1 (cognitive or mental)).tw OR exp "inhibition (psychology)"/ OR exp problem solving/ OR Social cognition.tw OR (Set adj1 (switching or shifting)).tw OR exp mathematics/ OR exp discrimination learning/ OR exp spatial learning/ OR exp verbalization/ OR (neurocognit$ adj3 (function$ or defic$ or abnormal$ or outcome$ or disorder$ or illness$ or problem$ or wellbeing or well-being or health or stress)).tw	OR exp Learning Disorders/ OR exp Visual Perception/ OR exp Spatial Perception/ OR exp Perceptual Motor Processes/ OR exp Response Inhibition/ OR exp "Interference (Learning)"/ OR exp Dual Task Performance/ OR exp discrimination learning/ OR exp "interference (learning)"/ OR exp nonverbal learning/ OR exp perceptual learning/ OR exp spatial learning/ OR exp verbal learning/ OR Intell$.tw OR Academic.tw OR Educatio$.tw OR IQ.tw OR Cogniti$.tw OR (outcome adj3 (education$ or academic or cogniti$ or neurocognit$)).tw OR (intell$ adj3 (quotient or def$ or abilit$)).tw OR exp neuropsychological test/ OR (Wechsler adj3 (intelligen$ or memory)).tw OR (neuropsychiatric adj3 (inventory or battery)).tw OR Neuropsychological test$.tw OR Psychomotor performance.tw OR Global cognitive function$.tw OR (memory adj3 (disorder$ or function$ or def$)).tw OR (Speed adj1 (processing or response)).tw OR (visuospatial adj1 (perception or function)).tw OR Verbal fluency.tw OR (flexibility adj1 (cognitive or mental)).tw OR Social cognition.tw OR (Set adj1 (switching or shifting)).tw OR exp Cognitive Processing Speed/ OR exp Reaction Time/ OR (function$ adj3 neurocognit$).tw

[1]CKD: chronic kidney disease

Supplementary Table 2: Characteristics of included studies

	Title, author	Country	Study type	Age (years) Mean (SD)	n	Patient cohort	Study outcome(s)	Outcome measure(s)		Follow-up time
								Test(s)	Indices/subtest(s)	
1	Amr 2013	Egypt	Cross-sectional	10.4 (3.80)	12	CKD I-V	Intelligence	WISC (Arabic version)	Full-Scale IQ Verbal IQ Performance IQ	N/A
				13.5 (2.90)	12	Dialysis				
				11.9 (3.70)	12	Control group				
2	Bawden 2004	Canada	Cross-sectional	11.8 (3.27)	22	CKD I-V	Intelligence	WISC-III	Full-Scale IQ Verbal IQ Performance IQ Reading Writing Arithmetic Word Attack Reading Comprehension	N/A
							Academic achievement	WIAT, WRAT3, Woodcock Reading Mastery Test-R		
				11.7 (3.09)	22	Control group				
							Language	Expressive One-Word Picture Vocabulary Test		
							Memory	WRAML, Nonverbal Selective Reminding Test		
							Visuomotor skills	Developmental Test of Visual-Motor Integration, Grooved Pegboard Test, Finger-Tapping Test		
3	Brouhard 2000	United States	Cross-sectional	13.7 (0.44)	26	Dialysis	Intelligence	Test of Nonverbal Intelligence-2	Reading Spelling Arithmetic	N/A
					36	Transplant recipients				
				13.7 (0.38)	62	Control group	Academic achievement	WRAT		
4	Crittenden 1985	United States	Cohort	R: 0.50-16	66	CKD I-V	Intelligence	WISC, WISC-R, WAIS, Stanford-Binet Intelligence Test, Cattell Infant Intelligence Test, Bayley Scales of Infant Development	Full-Scale IQ	Median: 14months (R: 2-40 months)
5	Crocker 2002	Canada	Cross-sectional	12.0 (2.41)	24	CKD I-V	Intelligence	WISC-III	Full-Scale IQ Verbal IQ Performance IQ Reading Spelling Arithmetic Word Attack Reading Comprehension Verbal Learning Sentence Memory Finger Windows	N/A
							Academic achievement	WIAT, WRAT3, Woodcock Reading Mastery-R		
							Language	Expressive One-Word Picture Vocabulary Test		
							Memory	WRAML, Nonverbal Selective Reminding Test		
							Visuomotor skills	Developmental Test of Visual-Motor Integration, Grooved Pegboard Test, Finger-Tapping Test		

6	Duquette 2008	United States	Cross-sectional	12.7 (3.32)	30	CKD I-V	Attention	Tower of London Test Gordon Diagnostic System Keith Auditory Continuous Performance Test Ruff Figural Fluency Test *WRAML/WASI scores as co-variates*	Total Move Total Execution Time Total Correct Mean Response Time Correct Variability Total Correct Correct Variability Perseverations Total Finger Windows Number/Letter	N/A
				11.7 (3.36)	41	Control group				
7	Duquette 2007	United States	Cross-sectional	12.7 (3.32)	30	CKD I-V	Intelligence Academic achievement	WASI WIAT-II	Full-Scale IQ Verbal IQ Performance IQ Word Reading Mathematics Reasoning Spelling	N/A
				11.7 (3.36)	41	Control group				
8	El-Shazly 2010	Egypt	Cross-sectional	-	25	CKD I-V	Intelligence	Stanford-Binet Intelligence Test	Full-Scale IQ	N/A
				-	25	Control group				
9	Falger 2008	Switzerland	Cross-sectional	Median: 14.1 (R: 6.50-17.0)	27	Transplant recipients	Intelligence	WISC-III or Kaufman Assessment Battery for Children	Full-Scale IQ Verbal IQ Performance IQ	N/A
10	Fennell 1990	United States	Cohort	13.6 (no SD)	56	CKD I-V	Intelligence Attention Memory	WISC-R, WAIS-R Continuous Performance Task Buschke Restricted Reminding Memory, Auditory Consonant Trigrams, Distraction Paradigm	Verbal IQ Digit Span Color Progressive Standard Progressive	6, 12, and 18months
				-	56	Control group				
							Visuomotor skills	Raven's Matrices, Beery-Butenica Development Test		
11	Fennell 1984	United States	Cohort	11.7 (3.70)	20	CKD I-V-to-transplant recipients	Intelligence Academic achievement Attention Executive function Memory	WISC Peabody Individual Achievement Test Continuous Performance Task Halstead-Reitan Category Test Free recall memory task	Full-Scale IQ Verbal IQ Performance IQ Digit Span	1 month; 1 year
				12.6 (3.90)	18	Control group				

12	Gipson 2006	United States	Cross-sectional	13.4 (3.20)	20	CKD I-V	Intelligence Executive function	WASI Tower of London Test, Gordon Diagnostic System, Controlled Oral Word Association Test, Ruff Figural Fluency Test, Woodcock-Johnson-III	Numbers Reversed Vigilance subtest	N/A
				12.9 (2.90)	18	Control group				
							Memory	WRAML		
13	Gulleroglu 2013	Turkey	Cross-sectional	12.6 (3.20)	20	CKD I-V	Attention	Cancellation Test		N/A
				13.5 (3.40)	20	Transplant recipients				
				14.2 (2.10)	20	Control group	Language	Visual and Auditory Number Assay Test		
							Visuomotor skills	Bender-Gestalt Test		
14	Haavisto 2012	Finland	Cross-sectional	11.1 (3.20)	50	Transplant recipients	Intelligence Attention Language Memory Visuomotor skills	WISC-III NEPSY-II	Full-Scale IQ Verbal IQ Performance IQ Auditory Attention and Response Set Speeded Naming Comprehension of Instru. Visuomotor Precision Memory for Designs Memory for Faces World List Interference Design Copying Geometric Puzzles Affect Recognition	N/A
15	Hartmann 2015	Germany	Cross-sectional	8.30 (1.40)	15	Transplant recipients	Intelligence	HAWIK-III, CFIT	Full-Scale IQ Verbal IQ Performance IQ CFT 1 sum 1 CFT 1 sum 2 CFT 1 sum 3 CFT 20-R	N/A
16	Hartung 2016	United States	Cross-sectional	16.3 (3.90)	92	CKD I-V	Executive function Episodic memory Complex cognition Social cognition	Penn CNB	Conditional Exclusion Continuous Performance Short Letter N-Back Word Memory Face Memory	N/A

#	Author	Country	Design	Age	N	Group	Domain	Measure	Outcomes	Follow-up
				16.0 (4.00)	69	Control group			Visual Object Learning Verbal Reasoning Matrix Reasoning Line Orientation Emotion Identification Emotion Differentiation Age Differentiation	
17	Hartung 2014	United States	Cross-sectional	Median: 7.60	66	CKD I-V	Intelligence Academic achievement Attention Executive function	WASI or WPPSI-R or Mullen Scales of Early Learning WIAT-II-A Conners' CPT-II Conners' Kiddie CPT BRIEF	Full-Scale IQ Verbal IQ Performance IQ Numerical operations Word reading Spelling Total achievement	N/A
18	Hooper 2015	United States	Cross-sectional	16.2 (3.87)	90	CKD I-V	Executive function	BRIEF (Parent-Report and Adult versions)	Behavior regulation index Metacognition index Global executive composite	N/A
				16.0 (3.96)	69	Control group				
19	Hooper 2011	United States	Cross-sectional	Median 13.0 (IQR, 15.0; R: 6.00-17.0)	368	CKD I-V	Intelligence Academic achievement Attention Executive function	WASI WIAT-II-A Conners' CPT-II BRIEF (Parent-Report)	Full-Scale IQ Verbal IQ Performance IQ Basic reading Spelling Numerical operations Total achievement	N/A
20	Hulstijn-Dirkmaat 1995	The Netherlands	Cohort	2.43 (1.58)	15	CKD I-V	Cognitive development	Bayley Developmental Scales <2.6y OR McCarthy Developmental Scales >2.6y		6 months
				2.58 (1.48)	16	Dialysis				
21	Hulstijn-Dirkmaat 1992	The Netherlands	Cross-sectional	3.08 (R: 1.75-2.92)	18	CKD I-V	Cognitive development	Bayley Developmental Scales <2.6y OR McCarthy Developmental Scales >2.6y		N/A
				2.92 (R: 2.25-3.75)	18	Control group				
22	Icard 2010	United States	Cohort	7.80 (no SD)	28	CKD I-V	Intelligence	Mullen Scales of Early Learning <5y OR WASI 6-18y	Full-Scale IQ	1 year
				10.7 (no SD)	6	Transplants recipients				
				10.3 (no SD)	23	Control group				
23	Johnson 2013	United States	Cross-	11.0 (no SD)	12	Transplant recipients	Intelligence	WISC-IV	Full-Scale IQ	N/A

			sectional	10.0 (no SD)	9	Control group			Verbal comprehension Perceptual reasoning Working memory Processing speed Word reading Numerical operations Spelling Total achievement	
							Academic achievement	WIAT-II-A		
							Executive function	BRIEF (Parent-Report)		
							Memory	WRAML2		
24	Kuyer 1990	The Netherlands	Cohort	9.50 (R: 4-14)	20	CKD I-V-to-transplant recipients	Intelligence	WISC-R or WPPSI-R	Full-Scale IQ Verbal IQ Performance IQ	Mean 1.7y (R: 5-47 months)
25	Lawry 1994	United States	Cross-sectional	14.9 (3.33)	11	Dialysis	Intelligence	WISC-R or WAIS-R	Full-Scale IQ Verbal IQ	N/A
				13.9 (3.22)	13	Transplant recipients	Academic achievement	Woodcock-Johnson Test	Performance IQ Mathematics Reading Written language	
26	Madden 2003	United Kingdom	Cross-sectional	5.84 (2.96)	16	Dialysis/transplant recipients	Intelligence	WISC-III, Griffiths Mental Development Scales	Full-Scale IQ	N/A
27	Mendley 2015	United States	Cross-sectional	Median: 13.0 (IQR: 7)	340	CKD I-V	Intelligence	WISC	Tower Task Digit Span Backward	N/A
							Attention	Conners' CPT-II		
							Executive function	D-KEFS		
28	Mendley 1999	United States	Cohort	14.2 (3.50)	9	CKD I-V-to-transplant recipients	Intelligence	WISC-III or WAIS-R	Full-Scale IQ Verbal IQ Performance IQ	1 year
							Attention	Conners' CPT, Stroop Color-Word Naming Test, Cognitive Abilities Test		
							Executive function	Paced Auditory Serial Addition Test OR the Children's Paced Auditory Serial Addition Test		
							Language	Buschke Selective Reminding Test		
							Visuomotor skills	Meier Visual Discrimination Test, Trail-making Test, Grooved Pegboard Test		
29	Molnar-Varga 2016	Hungary	Cross-sectional	13.4 (2.40)	35	Transplant recipients	Intelligence	Woodcock-Johnson International Edition	Full-Scale IQ Verbal Ability	N/A
				13.4 (2.50)	35	Control group			Thinking Ability Cognitive Efficiency	
30	Qvist 2002	Finland	Cross-	8.00 (R: 7-12)	33	Transplant recipients	Intelligence	WISC-R	Full-Scale IQ	N/A

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			sectional				Attention Language Memory Visuomotor skills	NEPSY	Verbal IQ Performance IQ	
31	Rasbury 1986	United States	Cohort	12.8 (3.61) 13.1 (3.56)	18 18	CKD I-V –to-dialysis Control group	Intelligence Memory	CFIT Paired associate learning test		4 days
32	Rasbury 1983	United States	Cohort	11.2 (3.40) 11.0 (3.60)	14 14	CKD I-V-to-transplant recipients Control group	Intelligence Academic achievement Attention Executive function Memory	WISC Peabody Individual Achievement Test Continuous Performance Task Halstead-Reitan Category Test Free Recall Memory Task	Full-Scale IQ Verbal IQ Performance IQ Mathematics Reading Information	1 month
33	Ruebner 2016	United States	Cross-sectional	16.3 (3.94) 15.9 (3.93)	92 70	CKD I-V Control group	Attention Executive function Language Memory Visuomotor skills	WISC-IV-I, Conners CPT-II BRIEF (Parent Report, Adult versions), D-KEFS WASI WISC-IV-I, WMS-III WASI, WMS-III	Vocabulary Similarities Matrix Reasoning Block Design Total Achievement Move Accuracy Ratio Digit Span Forward Digit Span Backward Spatial Span Forward Spatial Span Backward	N/A
34	Slickers 2007	United States	Cross-sectional	12.5 (3.20)	29	CKD I-V	Intelligence Attention Memory	WASI Gordon Diagnostic System WRAML	Vocabulary Block design Similarities Matrix reasoning	N/A

Legend
BRIEF: Behavior Rating Inventory of Executive Function
CFIT: Culture Fair Intelligence Test
CKD: chronic kidney disease
Conners CPT-II: Conners Continuous Performance Test, Second Edition
Conners Kiddie CPT: Conners Kiddie Continuous Performance Test
D-KEFS: Delis-Kaplan Executive Function System
HAWIK-III: Hamburg-Wechsler-Intelligenztests für Kinder (Hamburg-Wechsler-Intelligence Scale for Children), Third Edition
NEPSY: Developmental Neuropsychological Assessment
NEPSY-II: Developmental Neuropsychological Assessment, Second Assessment
Penn CNB: Penn's Computerized Neurocognitive Battery
WAIS-R: Wechsler Adult Intelligence Scale - Revised
WASI: Wechsler Abbreviated Scale of Intelligence
WIAT: Wechsler Individual Achievement Test
WIAT-II-A: Wechsler Individual Achievement Test-II Abbreviated
WISC: Wechsler Intelligence Scale for Children
WISC-R: Wechsler Intelligence Scale for Children - Revised
WISC-III: Wechsler Intelligence Scale for Children, Third Edition
WISC-IV: Wechsler Intelligence Scale for Children, Fourth Edition
WMS-III: Wechsler Memory Scale, Third Edition
WPPSI-III: Wechsler Preschool and Primary Scale of Intelligence, Third Edition
WRAML: Wide Range Assessment of Memory and Learning
WRAML2: Wide Range Assessment of Memory and Learning, Second Edition
WRAT: Wide Range Achievement Test
WRAT3: Wide Range Achievement Test-Revised, Third Edition

Supplementary Table 3 – Clinical outcomes

TABLE 2.1 Clinical outcomes – comparison with healthy controls									
Outcome	Domains	n (studies)	N (CKD)	Mean (SD)	N (controls)	Mean (SD)	Mean difference [95% CI]	Effect size (Cohen's d)	P	I² (%)
MILD-TO-MODERATE STAGE CKD										
Intelligence*	Full-Scale IQ									
	- Healthy controls	6	132	89.3 (15.3)	134	106 (13.6)	-16.2 [-22.2, -10.1]	1.15	<0.001	81
	- Normative data	11	582	94.2 (16.1)	-	100 (15)	-9.39 [-12.6, -6.18]	0.63	<0.001	87
	Verbal IQ									
	- Healthy controls	4	84	91.6 (16.2)	93	102 (13.4)	-7.84 [-13.5, -2.20]	0.70	0.006	61
	- Normative data	8	505	96.2 (16.7)	-	100 (15)	-8.07 [-12.2, -3.90]	0.54	<0.001	90
	Performance IQ									
	- Healthy controls	4	84	88.7 (14.3)	93	101 (12.4)	-11.7 [-13.2, -10.2]	0.92	<0.001	0
	- Normative data	8	505	94.3 (15.9)	-	100 (15)	-8.73 [-12.8, -4.69]	0.58	<0.001	91
	CFIT	1	18	13.6 (2.78)	18	14.8 (2.64)	-1.20 [-2.97, 0.57]	0.44	0.18	-
Academic achievement	Single Word Reading									
	- Healthy controls	2	52	96.9 (15.0)	63	100 (14.8)	-0.60 [-8.44, 7.24]	0.21	0.88	71
	- Normative data	4	444	96.0 (16.8)	-	100 (15)	-6.38 [-11.6, -1.17]	0.43	0.02	94
	Reading Comprehension									
	- Healthy controls	1	22	98.5 (2.60)	22	98.1 (3.50)	0.40 [-1.42, 2.22]	0.13	0.67	-
	- Normative data	2	46	98.6 (11.4)	-	100 (15)	-1.50 [-2.57, -0.43]	0.10	0.006	0
	Mathematics									
	- Healthy controls	2	52	92.8 (19.1)	63	105 (18.5)	-7.25 [-8.89, -5.62]	0.65	<0.001	24
	- Normative data	4	444	93.2 (14.5)	-	100 (15)	-9.58 [-16.0, -3.12]	0.64	0.004	95
	Spelling									
	- Healthy controls	2	52	98.7 (16.1)	63	97.1 (15.6)	4.76 [-0.52, 10.0]	0.10	0.08	44
	- Normative data	4	444	96.1 (17.5)	-	100 (15)	-5.18 [-8.27, -2.09]	0.35	0.001	80
	WIAT scores									
	- Total Achievement									
	Healthy controls	0	0	-	0	-	-	-	-	-
	Normative data	1	368	95.2 (17.8)	-	100 (15)	-4.80 [-6.62, -2.98]	0.32	<0.001	-
	WRMT-R									
	- Word Attack									
	Healthy controls	1	22	93.0 (4.10)	22	90.5 (3.20)	2.50 [0.33, 4.67]	0.68	0.02	-
	Normative data	2	46	91.9 (10.9)	-	100 (15)	-7.16 [-8.81, -5.52]	0.48	<0.001	0
	Peabody scores									
	- Reading	2	34	37.2 (14.6)	32	38.4 (11.8)	-1.08 [-7.40, 5.23]	0.09	0.84	0
	- Mathematics	2	34	37.2 (14.2)	32	39.6 (16.3)	-2.34 [-9.68, 4.99]	0.16	0.63	0
	- General Information	2	34	32.4 (19.6)	32	32.5 (16.0)	-0.12 [-8.69, 8.45]	0.01	0.98	0
Attention	Conners' CPT (T-scores)									
	- Omissions	1	368	51.7 (13.5)	-	50 (10)	1.70 [0.32, 3.08]	0.17	0.02	-
	- Commissions	1	368	51.7 (11.0)	-	50 (10)	1.70 [0.58, 2.82]	0.17	0.003	-

Domain	Test		N	Mean (SD)	N	Mean (SD)	Difference [CI]	ES	p	
	- Variability	1	368	50.1 (11.0)	-	50 (10)	0.10 [-1.02, 1.22]	0.01	0.86	-
	- Reaction Time	1	368	48.2 (11.9)	-	50 (10)	-1.80 [-3.02, -0.58]	0.18	0.004	-
	CPT (#/20)	1	20	14.8 (4.50)	18	14.7 (4.60)	0.10 [-2.80, 3.00]	0.02	0.95	-
	GDS Vigilance	1	29	96.0 (23.0)	-	100 (15)	-4.00 [-12.4, 4.37]	0.27	-0.35	-
Attention domains[a]	Focus/Execute									
	- Healthy controls	1	30	94.7 (11.4)	41	99.7 (8.51)	-5.06 [-9.91, -0.21]	0.50	0.04	-
	- Normative data	1	30	94.7 (11.4)	-	100 (15)	-5.30 [-9.38, -1.22]	0.35	0.01	-
	Sustain									
	- Healthy controls	1	30	94.4 (16.2)	41	103 (14.8)	-8.93 [-16.3, -1.56]	0.55	0.02	-
	- Normative data	1	30	94.4 (16.2)	-	100 (15)	-5.60 [-11.4, 0.20]	0.37	0.06	-
	Stability									
	- Healthy controls	1	30	87.2 (18.3)	41	97.0 (16.3)	-9.75 [-18.0, -1.52]	0.57	0.02	-
	- Normative data	1	30	87.2 (18.3)	-	100 (15)	-12.8 [-19.4, -6.25]	0.85	<0.001	-
	Shift									
	- Healthy controls	1	30	91.5 (11.0)	41	95.7 (11.9)	-4.24 [-9.60, 1.12]	0.37	0.12	-
	- Normative data	1	30	91.5 (11.0)	-	100 (15)	-8.50 [-12.4, -4.56]	0.57	<0.001	-
	Encode									
	- Healthy controls	1	30	88.7 (9.38)	41	99.5 (10.1)	-10.8 [-15.4, -6.23]	1.11	<0.001	-
	- Normative data	1	30	88.7 (9.38)	-	100 (15)	-11.3 [-14.7, -7.94]	0.75	<0.001	-
Cognitive development	Bayley/McCarthy Developmental Scales[b]	1	15	90.3 (14.3)	-	100 (16)	-9.70 [-16.9, -2.46]	0.61	0.009	-
Executive function	BRIEF (T-scores)									
	- Behavior Regulation									
	Healthy controls	1	65	54.3 (11.9)	50	51.4 (12.8)	2.88 [-1.69, 7.45]	0.23	0.22	-
	Normative data	1	368	53.5 (11.1)	-	50 (10)	3.50 [1.97, 5.03]	0.35	<0.001	-
	- Metacognition									
	Healthy controls	1	65	60.3 (12.0)	50	51.5 (11.2)	8.80 [4.54, 13.1]	0.76	<0.001	-
	Normative data	1	368	55.9 (11.5)	-	50 (10)	5.90 [4.34, 7.46]	0.59	<0.001	-
	- Global Executive									
	Healthy controls	1	65	58.7 (11.5)	50	51.5 (12.0)	7.21 [2.87, 11.6]	0.61	0.001	-
	Normative data	1	368	55.2 (11.6)	-	50 (10)	5.20 [3.64, 6.76]	0.52	<0.001	-
	HRPS Category Test	1	20	47.7 (21.1)	18	41.6 (23.0)	6.10 [-7.99, 20.2]	0.28	0.40	-
	Initiation									
	- Healthy controls	1	20	77.6 (19.2)	18	106 (14.5)	-28.4 [-39.2, -17.7]	1.67	<0.001	-
	- Normative data	1	20	77.6 (19.2)	-	100 (15)	-22.4 [-30.8, -14.0]	1.49	<0.001	-
	Sustaining									
	- Healthy controls	1	20	85.0 (16.5)	18	101 (19.3)	-15.6 [-27.0, -4.10]	0.89	0.008	-
	- Normative data	1	20	85.0 (16.5)	-	100 (15)	-15.1 [-22.3, -7.83]	1.01	<0.001	-
	Set-Shifting									
	- Healthy controls	1	20	96.6 (17.3)	18	96.2 (13.5)	0.68 [-11.0, 12.4]	0.03	0.91	-
	- Normative data	1	20	96.6 (17.3)	-	100 (15)	-3.44 [-11.0, 4.15]	0.23	0.37	-
	Inhibition									

Domain	Test	n	N	Value (SD)	N	Value (SD)	MD [CI]	ES	p	I²
	- Healthy controls	1	20	95.9 (19.2)	18	97.6 (19.5)	-1.76 [-14.1, 10.6]	0.04	0.78	-
	- Normative data	1	20	95.9 (19.2)	-	100 (15)	-4.12 [-12.5, 4.29]	0.27	0.34	-
Language	EOWPVT[c]	1	24	97.9 (18.2)	-	100 (15)	-2.10 [-9.39, 5.18]	0.14	0.57	-
Memory	WRAML scores									
	- General Memory Index	1	29	88.0 (16.0)	-	100 (15)	-12.0 [-17.8, -6.18]	0.80	<0.001	-
	- Finger Windows									
	Healthy controls	2	42	8.77 (2.09)	40	9.14 (1.72)	-0.37 [-3.29, 2.55]	0.10	0.80	91
	Normative data	2	42	8.77 (2.09)	-	10 (3)	-1.01 [-1.76, -0.26]	0.34	0.008	44
	- Sentence Memory									
	Healthy controls	2	42	7.91 (2.08)	40	10.1 (1.61)	-2.21 [-5.02, 0.59]	0.51	0.12	91
	Normative data	2	42	7.91 (2.08)	-	10 (3)	-1.92 [-2.21, -1.63]	0.64	<0.001	0
	- Verbal Learning									
	Healthy controls	2	42	9.87 (2.03)	40	11.1 (1.59)	-1.02 [-1.35, -0.69]	0.32	<0.001	0
	Normative data	2	42	9.87 (2.03)	-	10 (3)	0.06 [-0.71, 0.84]	0.02	-0.87	47
	- Picture Memory									
	Healthy controls	1	20	7.75 (2.99)	18	10.2 (2.81)	-2.43 [-4.27, -0.59]	0.39	0.010	-
	Normative data	1	20	7.75 (2.99)	-	10 (3)	-2.25 [-3.56, -0.94]	0.75	<0.001	-
	- Design Memory									
	Healthy controls	1	20	8.45 (1.91)	18	11.4 (3.02)	-2.90 [-4.53, -1.27]	0.50	<0.001	-
	Normative data	1	20	8.45 (1.91)	-	10 (3)	-1.55 [-2.39, -0.71]	0.52	<0.001	-
	- Story Memory									
	Healthy controls	1	20	7.95 (2.91)	18	11.5 (2.53)	-3.52 [-5.25, -1.79]	0.55	<0.001	-
	Normative data	1	20	7.95 (2.91)	-	10 (3)	-2.05 [-3.33, -0.77]	0.68	0.002	-
	- Sound Symbol									
	Healthy controls	1	20	9.70 (3.05)	18	12.9 (2.05)	-3.24 [-4.88, -1.60]	0.52	<0.001	-
	Normative data	1	20	9.70 (3.05)	-	10 (3)	-0.30 [-1.64, 1.04]	0.10	0.66	-
	- Visual Learning									
	Healthy controls	1	20	10.1 (2.25)	18	11.8 (2.97)	-1.66 [-3.35, 0.03]	0.31	0.05	-
	Normative data	1	20	10.1 (2.25)	-	10 (3)	0.10 [-0.89, 1.09]	0.03	0.84	-
	- Number/Letter									
	Healthy controls	1	20	7.15 (1.95)	18	10.0 (2.18)	-2.85 [-4.17, -1.53]	0.57	<0.001	-
	Normative data	1	20	7.15 (1.95)	-	10 (3)	-2.85 [-3.70, -2.00]	0.95	<0.001	-
	NSRT (Z-scores)									
	- Recall									
	Healthy controls	1	22	-0.80 (0.20)	22	-0.20 (0.20)	-0.60 [-0.72, -0.48]	0.83	<0.001	-
	Normative data	1	22	-0.80 (0.20)	-	0 (1)	-0.80 [-0.88, -0.72]	0.80	<0.001	-
	- Long Term Storage									
	Healthy controls	1	22	-0.60 (0.20)	22	-0.10 (0.20)	-0.50 [-0.62, -0.38]	0.78	<0.001	-
	Normative data	1	22	-0.60 (0.20)	-	0 (1)	-0.60 [-0.68, -0.52]	0.60	<0.001	-
	- Continuous Long Term									

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	Healthy controls	1	22	-0.50 (0.20)	22	-0.20 (0.30)	-0.30 [-0.45, -0.15]	0.51	<0.001	-
	Normative data	1	22	-0.50 (0.20)	-	0 (1)	-0.50 [-0.58, -0.42]	0.50	<0.001	-
	WISC Digit Span									
	- Healthy controls	1	20	8.50 (2.70)	18	8.60 (3.00)	-0.10 [-1.92, 1.72]	0.04	0.91	-
	- Normative data	1	20	8.50 (2.70)	-	10 (3)	-1.50 [-2.68, -0.32]	0.50	0.01	-
	FRM Total Score	1	20	89.4 (23.4)	18	95.8 (27.1)	-6.40 [-22.6, 9.78]	0.25	0.44	-
	FRM1 score	1	20	5.00 (2.00)	18	5.20 (2.10)	-0.20 [-1.51, 1.11]	0.10	0.76	-
	Penn CNB[d] (Z-scores)									
Executive control	Abstraction	1	92	-	69	-	-0.20 [-0.51, 0.12]	-	0.22	-
	Attention	1	92	-	69	-	-0.35 [-0.67, -0.03]	-	0.03	-
	Working memory	1	92	-	69	-	-0.19 [-0.61, 0.24]	-	0.39	-
Episodic memory	Verbal memory	1	92	-	69	-	-0.25 [-0.65, 0.15]	-	0.23	-
	Facial memory	1	92	-	69	-	-0.32 [-0.68, 0.04]	-	0.08	-
	Spatial memory	1	92	-	69	-	-0.35 [-0.72, 0.01]	-	0.06	-
Complex cognition	Verbal reasoning	1	92	-	69	-	-0.53 [-0.87, -0.19]	-	0.002	-
	Non-verbal reasoning	1	92	-	69	-	-0.52 [-0.83, -0.22]	-	0.001	-
	Spatial processing	1	92	-	69	-	-0.64 [-0.99, -0.29]	-	<0.001	-
Social cognition	Emotion identification	1	92	-	69	-	-0.28 [-0.64, 0.09]	-	0.13	-
	Emotion differentiation	1	92	-	69	-	-0.22 [-0.59, 0.14]	-	0.23	-
	Age differentiation	1	92	-	69	-	-0.24 [-0.61, 0.14]	-	0.21	-
DIALYSIS										
Intelligence	Full-Scale IQ									
	- Healthy controls	1	12	75.5 (12.2)	12	105 (10.3)	-29.5 [-38.5, -20.5]	2.61	<0.001	-
	- Normative data	2	23	83.8 (14.6)	-	100 (15)	-16.2 [-33.2, 0.86]	1.08	0.06	87
	Verbal IQ									
	- Healthy controls	1	12	76.7 (6.50)	12	94.9 (6.00)	-18.2 [-23.2, -13.2]	1.52	<0.001	-
	- Normative data	2	23	83.9 (12.4)	-	100 (15)	-14.1 [-33.2, 4.89]	0.94	0.15	92
	Performance IQ									
	- Healthy controls	1	12	73.8 (10.1)	12	94.9 (10.1)	-21.1 [-29.2, -13.0]	2.09	<0.001	-
	- Normative data	2	23	84.4 (14.1)	-	100 (15)	-15.5 [-37.3, 6.21]	1.03	0.16	93
Academic achievement	WRAT scores									
	- Reading									
	Healthy controls	1	26	90.0 (4.00)	26	100 (3.00)	-10.0 [-11.9, -8.08]	0.82	<0.001	-
	Normative data	1	26	90.0 (4.00)	-	100 (15)	-10.0 [-11.5, -8.46]	0.67	<0.001	-
	- Arithmetic									
	Healthy controls	1	26	89.0 (4.00)	26	92.0 (3.00)	-3.00 [-4.92, -1.08]	0.39	0.002	-
	Normative data	1	26	89.0 (4.00)	-	100 (15)	-11.0 [-12.5, -9.46]	0.73	<0.001	-
	- Spelling									
	Healthy controls	1	26	85.0 (4.00)	26	90.0 (3.00)	-5.00 [-6.92, -3.08]	0.14	<0.001	-
	Normative data	1	26	85.0 (4.00)	-	100 (15)	-15.0 [-16.5, -13.5]	1.00	<0.001	-
	TONI-2 percentiles	1	26	27.0 (4.00)	26	32.0 (5.00)	-5.00 [-7.46, -2.54]	0.48	<0.001	-
Cognitive development	Bayley/McCarthy	1	16	67.6 (17.3)	-	100 (16)	-32.4 [-40.9, -23.9]	1.94	<0.001	-

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	Developmental Scales[b]									
TRANSPLANT RECIPIENTS										
Intelligence	Full-Scale IQ									
	- Healthy controls	2	18	75.5 (16.6)	32	109 (17.2)	-29.4 [-53.9, -4.77]	1.98	0.02	78
	- Normative data	7	153	88.3 (16.9)	-	100 (15)	-11.2 [-17.8, -4.50]	0.75	0.001	85
	Verbal IQ									
	- Healthy controls	0	0	-	0	-	-	-	-	-
	- Normative data	5	135	93.4 (18.2)	-	100 (15)	-4.06 [-11.1, 3.03]	0.27	0.26	85
	Performance IQ									
	- Healthy controls	0	0	-	0	-	-	-	-	-
	- Normative data	5	135	86.9 (19.6)	-	100 (15)	-10.5 [-16.8, -4.13]	0.70	0.001	78
	WJIE scores									
	- Full-scale									
	Healthy controls	1	35	85.0 (26.0)	35	107 (10.0)	-22.0 [-31.2, -12.8]	1.12	<0.001	-
	Normative data	1	35	85.0 (26.0)	-	100 (15)	-15.0 [-23.6, -6.39]	1.00	<0.001	-
	- Verbal ability									
	Healthy controls	1	35	97.0 (25.0)	35	110 (13.0)	-13.0 [-22.3, -3.66]	0.65	0.006	-
	Normative data	1	35	97.0 (25.0)	-	100 (15)	-3.00 [-11.3, 5.28]	0.20	0.48	-
	- Thinking ability									
	Healthy controls	1	35	88.0 (28.0)	35	107 (10.0)	-19.0 [-28.9, -9.15]	0.90	<0.001	-
	Normative data	1	35	88.0 (28.0)	-	100 (15)	-12.0 [-21.3, -2.72]	0.80	0.01	-
	- Cognitive efficiency									
	Healthy controls	1	35	82.0 (25.0)	35	103 (13.0)	-21.0 [-30.3, -11.7]	0.96	<0.001	-
	Normative data	1	35	82.0 (25.0)	-	100 (15)	-18.0 [-26.3, -9.72]	1.20	<0.001	-
	WISC-IV scores									
	- Verbal Comprehension									
	Healthy controls	1	12	82.4 (16.6)	9	-	-	-	>0.05[e]	-
	Normative data	1	12	82.4 (16.6)	-	100 (15)	-17.6 [-27.0, -8.21]	1.17	<0.001	-
	- Perceptual Reasoning									
	Healthy controls	1	12	81.8 (17.4)	9	100 (no SD)	-18.2	-	>0.05[e]	-
	Normative data	1	12	81.8 (17.4)	-	100 (15)	-18.2 [-28.0, -8.36]	1.21	<0.001	-
	- Working Memory									
	Healthy controls	1	12	80.1 (12.3)	9	92.0 (17.8)	-11.9 [-25.5, 1.65]	0.78	0.09	-
	Normative data	1	12	80.1 (12.3)	-	100 (15)	-19.9 [-26.9, -12.9]	1.33	<0.001	-
	- Processing Speed									
	Healthy controls	1	12	80.8 (13.9)	9	96.0 (16.5)	-15.2 [-28.5, -1.86]	1.00	0.03	-
	Normative data	1	12	80.8 (13.9)	-	100 (15)	-19.2 [-27.1, -11.3]	1.28	<0.001	-
	KABC	1	12	94.5 (6.50)	-	100 (15)	-5.50 [-14.5, 3.51]	0.37	0.23	-
	CFIT 1, Sum 1 (overall)	1	12	94.5 (12.2)	12	100 (24)	-5.40 [-20.6, 9.83]	0.29	0.49	-
	CFIT 1, Sum 3 (fluid)	1	15	98.3 (11.1)	15	100 (24)	-1.70 [-15.1, 11.7]	0.09	0.80	-
Academic achievement	Single Word Reading									
	- Healthy controls	2	48	90.9 (10.7)	45	99.9 (8.13)	-7.06 [-8.44, -5.68]	0.95	<0.001	0

	- Normative data	2	48	90.9 (10.7)	-	100 (15)	-9.31 [-16.7, -1.90]	0.62	0.01	54
	Mathematics									
	- Healthy controls	2	48	87.1 (10.3)	45	98.4 (11.0)	-10.0 [-11.4, -8.65]	1.06	<0.001	0
	- Normative data	2	48	87.1 (10.3)	-	100 (15)	-12.0 [-13.0, -11.1]	0.80	<0.001	0
	Spelling									
	- Healthy controls	2	48	89.7 (9.10)	45	99.4 (7.85)	-11.1 [-22.5, 0.34]	1.14	0.06	65
	- Normative data	2	48	89.7 (9.10)	-	100 (15)	-9.20 [-11.2, -7.25]	0.61	<0.001	6
	- Total Achievement									
	Healthy controls	1	12	83.7 (17.3)	9	103 (20.2)	-19.1 [-35.5, -2.67]	1.03	0.02	-
	Normative data	1	12	83.7 (17.3)	-	100 (15)	-16.3 [-26.1, -6.51]	1.09	0.001	-
	TONI-2 scores	1	36	35.0 (5.00)	36	56.0 (6.00)	-21.0 [-23.6, -18.5]	3.80	<0.001	-
	Peabody scores									
	- Reading	1	20	47.8 (16.0)	18	44.7 (10.6)	3.10 [-5.45, 11.7]	0.23	0.48	-
	- Mathematics	1	20	46.3 (13.4)	18	42.8 (11.7)	3.50 [-4.48, 11.5]	0.28	0.39	-
	- General Information	1	20	39.5 (16.5)	18	42.6 (16.9)	-3.10 [-13.7, 7.54]	0.19	0.57	-
Attention	NEPSY	1	33	-0.21 (0.39)	-	0 (1)	-0.21 [-0.34, -0.08]	0.21	0.002	-
	NEPSY-II scores									
	- Auditory Attention									
	Healthy controls	1	49	9.60	49	10.4	-0.80	-	>0.05[f]	-
	Normative data	1	49	9.60	-	10 (3)	-0.40	0.13	-	-
Executive function	BRIEF (T-scores)									
	- Behavior Regulation									
	Healthy controls	1	9	48.3 (6.40)	9	45.3 (6.50)	3.00 [-2.96, 8.96]	0.47	0.32	-
	Normative data	1	9	48.3 (6.40)	-	50 (10)	-1.70 [-5.88, 2.48]	0.17	0.43	-
	- Metacognition									
	Healthy controls	1	9	61.4 (16.3)	9	46.7 (6.40)	14.7 [3.26, 26.1]	1.19	0.01	-
	Normative data	1	9	61.4 (16.3)	-	50 (10)	11.4 [0.75, 22.1]	0.11	0.04	-
	- Global Executive									
	Healthy controls	1	9	55.8 (12.1)	9	45.7 (5.70)	10.1 [1.36, 18.8]	1.07	0.02	-
	Normative data	1	9	55.8 (12.1)	-	50 (10)	5.80 [-2.11, 13.7]	0.58	0.15	-
	VANAT scores									
	- Auditory verbal (#)	1	20	5.07	20	7.89	-2.82	-	<0.05[g]	-
	- Visual verbal (#)	1	20	5.87	20	7.92	-2.05	-	<0.05[g]	-
	- Auditory written (#)	1	20	5.12	20	7.68	-2.56	-	<0.05[g]	-
	- Visual written (#)	1	20	5.64	20	7.90	-2.26	-	<0.05[g]	-
	NEPSY-II scores									
	- Auditory Attention and Response Set									
	Healthy controls	1	49	8.70	49	10.0	-1.30	-	<0.05[f]	-
	Normative data	1	49	8.70	-	10 (3)	-1.30	0.43	-	-
Language	NEPSY	1	33	-0.18 (0.13)	-	0 (1)	-0.18 [-0.23, -0.14]	0.18	<0.001	-
	NEPSY-II scores									

Domain	Test / Subtest									
	- Speeded Naming									
	Healthy controls	1	49	8.20	49	9.85	-1.65	-	<0.05[f]	-
	Normative data	1	49	8.20	-	10 (3)	-1.80	0.60	-	-
	- Instructions									
	Healthy controls	1	49	7.10	49	10.1	-3.00	-	<0.001[f]	-
	Normative data	1	49	7.10	-	10 (3)	-2.90	0.97	-	-
Memory	WRAML scores									
	- Verbal Memory									
	Healthy controls	1	9	88.8 (11.0)	9	101 (19.5)	-11.9 [-26.5, 2.73]	0.77	0.11	-
	Normative data	1	9	88.8 (11.0)	-	100 (15)	-11.2 [-18.4, -4.01]	0.75	0.002	-
	- Visual Memory									
	Healthy controls	1	9	88.7 (8.80)	9	86.7 (11.0)	2.00 [-7.20, 11.2]	0.20	0.67	-
	Normative data	1	9	88.7 (8.80)	-	100 (15)	-11.3 [-17.1, -5.55]	0.75	<0.001	-
	- Screening Memory									
	Healthy controls	1	9	86.6 (9.40)	9	92.7 (14.2)	-6.10 [-17.2, 5.03]	0.51	0.28	-
	Normative data	1	9	86.6 (9.40)	-	100 (15)	-13.4 [-19.5, -7.26]	0.89	<0.001	-
	NEPSY	1	33	-0.38 (0.22)	-	0 (1)	-0.38 [-0.46, -0.31]	0.38	<0.001	-
	NEPSY-II scores									
	- Memory for Designs									
	Healthy controls	1	49	8.70	49	9.70	-1.00	-	>0.05[f]	-
	Normative data	1	49	8.70	-	10 (3)	-1.30	0.43	-	-
	- Memory for Faces									
	Healthy controls	1	49	8.20	49	9.00	-0.80	-	>0.05[f]	-
	Normative data	1	49	8.20	-	10 (3)	-1.80	0.60	-	-
	- Word List Inference									
	Healthy controls	1	49	8.00	49	10.2	-2.20	-	<0.01[f]	-
	Normative data	1	49	8.00	-	10 (3)	-2.00	0.67	-	-
Social cognition	NEPSY-II scores									
	- Affect Recognition									
	Healthy controls	1	49	8.10	49	10.3	-2.20	-	<0.001[f]	-
	Normative data	1	49	8.10	-	10 (3)	-1.90	0.63	-	-
Visuomotor skills	NEPSY	1	33	-0.47 (0.26)	-	0 (1)	-0.47 [-0.97, 0.03]	0.47	0.07	-
	NEPSY-II scores									
	- Design Copying									
	Healthy controls	1	49	6.10	49	9.10	-3.00	-	<0.001[f]	-
	Normative data	1	49	6.10	-	10 (3)	-3.00	1.00	-	-
	- Geometric Puzzles									
	Healthy controls	1	49	7.90	49	9.90	-2.00	-	<0.01[f]	-
	Normative data	1	49	7.90	-	10 (3)	-2.10	0.70	-	-
	- Visuomotor Precision									
	Healthy controls	1	49	7.30	49	9.80	-2.50	-	<0.001[f]	-
	Normative data	1	49	7.30	-	10 (3)	-2.70	0.90	-	-

TABLE 2.2 Clinical outcomes – comparison between CKD stages										
Outcome	Domains	N (studies)	N	Mean (SD)	N	Mean (SD)	Mean difference [95% CI]	Effect size (Cohen's d)	P	I² (%)
PREDIALYSIS vs DIALYSIS										
Intelligence	Full-Scale IQ	1	12	86.7 (7.90)	12	75.5 (12.2)	11.2 [2.98, 19.4]	1.09	0.008	-
	Verbal IQ	1	12	88.2 (17.1)	12	76.7 (6.50)	11.5 [1.15, 21.9]	0.89	0.03	-
	Performance IQ	1	12	79.8 (11.0)	12	73.8 (10.1)	6.00 [-2.45, 14.5]	0.57	0.16	-
Cognitive development	Bayley/McCarthy Developmental Scales[b]	1	15	90.3 (14.3)	16	67.6 (17.3)	22.7 [11.6, 33.9]	1.43	<0.001	
PREDIALYSIS vs. TRANSPLANT										
Intelligence	Full-Scale IQ	1	28	87.2 (17.8)	6	72.8 (20.0)	14.3 [-2.95, 31.6]	0.76	0.10	-
Attention regulation	Conners' CPT									
	- Correct hits (#)	1	9	293 (44.0)	9	311 (22.0)	-18.0 [-50.1, 14.1]	0.52	0.27	-
	- False alarms (#)	1	9	14.0 (9.00)	9	13.0 (9.00)	1.00 [-7.32, 9.32]	0.11	0.81	-
	- Reaction times (s)	1	9	0.47 (0.10)	9	0.38 (0.72)	0.09 [-0.38, 0.56]	0.18	0.71	-
	- Discrimination (Z-scores)	1	9	2.19 (1.29)	9	0.62 (1.55)	-0.76 [-1.97, 0.45]	1.05	0.22	-
Executive function	PASAT, ChiPASAT (Z-scores)	1	9	-0.07 (1.42)	9	-0.41 (0.62)	0.34 [-0.67, 1.35]	0.31	0.51	-
	VANAT scores									
	- Auditory verbal (#)	1	20	4.56	20	5.07	-0.51	-	<0.05[g]	-
	- Visual verbal (#)	1	20	4.65	20	5.87	-1.22	-	<0.05[g]	-
	- Auditory written (#)	1	20	5.01	20	5.12	-0.11	-	<0.05[g]	-
	- Visual written (#)	1	20	4.78	20	5.64	-0.86	-	<0.05[g]	-
TRANSPLANT vs. DIALYSIS										
Intelligence	Full-Scale IQ	1	13	103 (12.0)	11	92.9 (16.9)	10.1 [-1.81, 22.0]	0.69	0.10	-
	Verbal IQ	1	13	103 (13.5)	11	91.6 (16.6)	11.4 [-0.88, 23.6]	0.75	0.07	-
	Performance IQ	1	13	103 (14.4)	11	96.0 (17.4)	7.08 [-5.86, 20.0]	0.44	0.28	-
Academic achievement	WJ-R scores									
	- Reading	1	13	16.4 (7.66)	11	15.6 (7.70)	0.77 [-5.40, 6.94]	0.10	0.81	-
	- Mathematics	1	13	16.1 (7.78)	11	13.8 (5.82)	2.34 [-3.11, 7.79]	0.33	0.40	-
	- Written	1	13	16.2 (9.05)	11	11.2 (7.18)	5.00 [-1.50, 11.5]	0.61	0.13	-
	WRAT scores									
	- Reading	1	36	93.0 (3.00)	26	90.0 (4.00)	3.00 [-1.18, 4.82]	0.85	0.001	-
	- Arithmetic	1	36	88.0 (3.00)	26	89.0 (4.00)	-1.00 [-2.82, 0.82]	0.28	0.28	-
	- Spelling	1	36	91.0 (3.00)	26	85.0 (4.00)	6.00 [4.18, 7.82]	0.65	<0.001	-
	TONI-2 percentiles	1	36	35.0 (5.00)	26	27.0 (4.00)	8.00 [5.76, 10.2]	0.66	<0.001	-

IQ: Intelligence Quotient – scoring mean 100, SD 15 (80-89 low average, 90-109 average, 110-119 high average)

*Crittenden 1985: used 6 outcome measures to assess full-scale IQ in patients with end-stage kidney disease (see Supp. Table 2)

Bender-Gestalt: Bender Visual Motor Gestalt Test – scoring focussed on examinee's specific difficulties and behavior (Gulleroglu 2013 – results below)

- *CKD (n=20) – abnormal in 12 patients (60%); controls (n=18) – abnormal in 3 patients (15%); **relative risk** = 4.00 [95% CI: 1.33, 12.1], p=0.01*

- *Transplant (n=20) – abnormal in 8 patients (40%); controls (n=18) – abnormal in 3 patients (15%); **relative risk** = 2.67 [95% CI: 0.82, 8.62], p=0.10*
- *CKD (n=20) – abnormal in 12 patients (60%); transplant (n=20) – abnormal in 8 patients (40%); **relative risk** = 1.50 [95% CI: 0.79, 2.86], p=0.22*

BRIEF: Behavior Rating Inventory of Executive Function – T scores = mean 50, SD 10 (higher scores reflect more impairment)
CFIT: Culture Fair Intelligence Test - # of correct responses, or scoring mean 100, SD 24
ChiPASAT: Children's Paced Auditory Serial Addition Task – Z-scores = mean 0, SD 1 (higher scores reflect less impairment)
CKD: chronic kidney disease
Conners' CPT: Conners' Continuous Performance Test – T-scores = mean 50, SD 10 (higher scores reflect more impairment)
CPT: Continuous Performance Test – number of hits out of 20 (Fennell 1984)
Digit Span: Subtest of WISC – scoring mean 10, SD 3
EOWPVT: Expressive One Word Picture Vocabulary Test – scoring mean 100, SD 15
GDS: Gordon Diagnostic System – scoring mean 100, SD 15
HRPS Category Test: Halstead-Reitan Problem Solving Category Test – scores above 41 suggest brain impairment for ages 15-45 years
KABC: Kaufmann Assessment Battery for Children – scoring mean 100, SD 15
NEPSY: Finnish Neuropsychological Test Battery for Children – standard deviation scale +1 to -3 (0 to +1 for normal, -1 to -3 for increasing impairment)
NEPSY-II: Finnish Neuropsychological Test Battery for Children – scoring mean 10, SD 3
NSRT: Nonverbal Selective Reminding Test – Z scores = mean 0, SD 1 (higher scores reflect less impairment)
PASAT: Paced Auditory Serial Addition Test – Z-scores = mean 0, SD 1 (higher scores reflect less impairment)
Peabody: Peabody Individual Achievement Test – uncertain scoring presentation by Fennell 1984
Penn CNB: Penn's Computerized Neurocognitive Battery – scoring presentation as Z-score differences between patient cohorts
TONI-2: Test of Nonverbal Intelligence, Second Edition – scoring by percentile ranks (mean 50)
VANAT: Visual and Auditory Number Assay Test – scoring by number of repeated digits correctly recorded
WJ-R: Woodcock-Johnson Tests of Cognitive Abilities, Revised Edition – scoring by age-equivalent scores
WIAT: Wechsler Individual Achievement Test – scoring mean 100, SD 15 (80-89 low average, 90-109 average, 110-119 high average)
WRAML: Wide Range Assessment of Memory and Learning – scoring mean 10, SD 3 (6.0-7.9 low average, 8.0-11.9 average, 12.0-13.9 high average)
WRAT: Wide Range Achievement Test – scoring mean 100, SD 15 (80-89 low average, 90-109 average, 110-119 high average)
WRMT-R: Woodcock Reading Mastery Tests-Revised – scoring mean 100, SD 15 (80-89 low average, 90-109 average, 110-119 high average)
[a] Domains in Mirsky's model of attention (Duquette 2008)
[b] Cognitive development - scoring mean 100, SD 16
[c] Two studies used the EOWPVT, but results were not reported in one study (Bawden 2004)
[d] Results reported as Z-score differences in Hartung 2016
[e] WISC-IV scores for Verbal Comprehension and Perceptual Reasoning Indices not given in Johnson 2013; p-values as reported in study
[f] p-values reported by Haavisto 2012
[g] p-values reported by Gulleroglu 2013

NB// Missing data in:
- *El-Shazly 2010: IQ scores*
- *Fennell 1990: only p-values reported for all outcomes*
- *Gipson 2006: IQ scores*
- *Gulleroglu: Cancellation Test results*
- *Haavisto 2012: SD for all outcomes*
- *Hartung 2016: Z-scores for all outcomes*
- *Hartung 2014: mean and SD for all outcomes*
- *Hulstijn-Dirkmaat 1992: SD not reported for all outcomes*
- *Mendley 2015: mean and SD for all outcomes)*
- *Mendley 1999: results for the Stroop Color-Word Naming Test, Buschke Selective Reminding Test, Meier Visual Discrimination Test, Grooved Pegboard Test, and the Trail-making Test*
- *Rasbury 1983: results for the Free Recall Memory Task*

Supplementary Figure 1.1: Single Word Reading Accuracy - Predialysis vs normative data

Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Random, 95% CI
Duquette 2007	-0.17	3.47	12.8%	-0.17 [-6.97, 6.63]
Crocker 2002	-9.04	2.98	15.6%	-9.04 [-14.88, -3.20]
Hooper 2011	-3.5	0.89	35.7%	-3.50 [-5.24, -1.76]
Bawden 2004	-7	0.87	35.9%	-7.00 [-8.71, -5.29]
Total (95% CI)			100.0%	-5.19 [-8.14, -2.25]

Heterogeneity: Tau² = 5.52; Chi² = 11.67, df = 3 (P = 0.009); I² = 74%
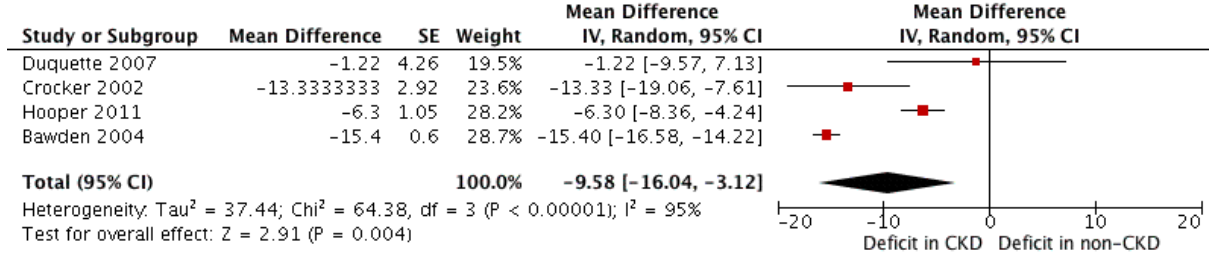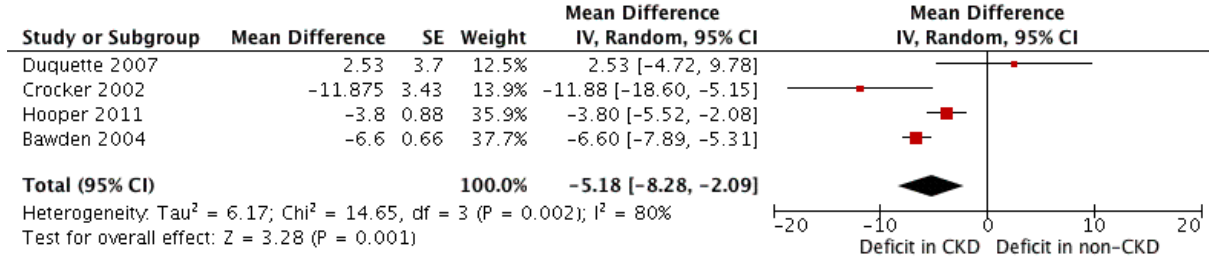Test for overall effect: Z = 3.46 (P = 0.0005)
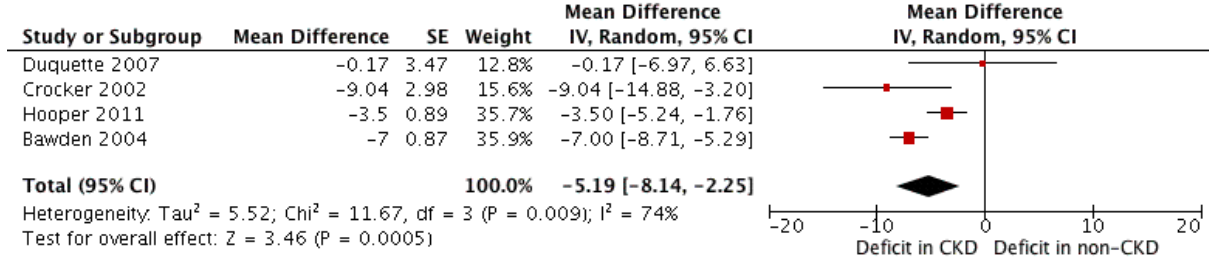
Supplementary Figure 1.2: Reading Comprehension - Predialysis vs normative data

Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Random, 95% CI
Crocker 2002	-1.37	3.2	2.9%	-1.37 [-7.64, 4.90]
Bawden 2004	-1.5	0.55	97.1%	-1.50 [-2.58, -0.42]
Total (95% CI)			100.0%	-1.50 [-2.56, -0.43]

Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.97); I² = 0%
Test for overall effect: Z = 2.76 (P = 0.006)
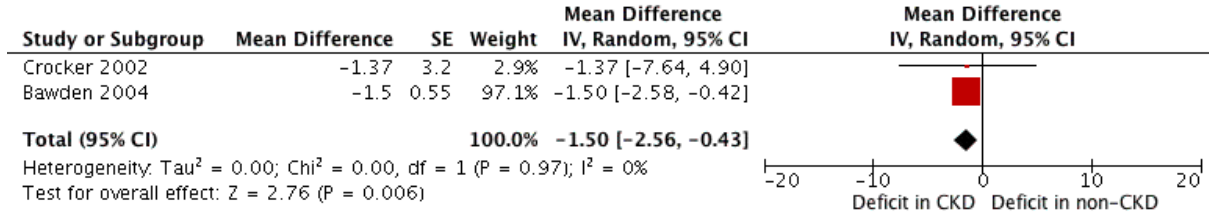
Supplementary Figure 1.3: Mathematics - Predialysis vs normative data

Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Random, 95% CI
Duquette 2007	-1.22	4.26	19.5%	-1.22 [-9.57, 7.13]
Crocker 2002	-13.3333333	2.92	23.6%	-13.33 [-19.06, -7.61]
Hooper 2011	-6.3	1.05	28.2%	-6.30 [-8.36, -4.24]
Bawden 2004	-15.4	0.6	28.7%	-15.40 [-16.58, -14.22]
Total (95% CI)			100.0%	-9.58 [-16.04, -3.12]

Heterogeneity: Tau² = 37.44; Chi² = 64.38, df = 3 (P < 0.00001); I² = 95%
Test for overall effect: Z = 2.91 (P = 0.004)

Supplementary Figure 1.4: Spelling - Predialysis vs normative data

Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Random, 95% CI
Duquette 2007	2.53	3.7	12.5%	2.53 [-4.72, 9.78]
Crocker 2002	-11.875	3.43	13.9%	-11.88 [-18.60, -5.15]
Hooper 2011	-3.8	0.88	35.9%	-3.80 [-5.52, -2.08]
Bawden 2004	-6.6	0.66	37.7%	-6.60 [-7.89, -5.31]
Total (95% CI)			100.0%	-5.18 [-8.28, -2.09]

Heterogeneity: Tau² = 6.17; Chi² = 14.65, df = 3 (P = 0.002); I² = 80%
Test for overall effect: Z = 3.28 (P = 0.001)

Supplementary Table 4: Funnel plots (full-scale IQ)

Comparison against health controls	Comparison against normative population data
Mild-to-moderate stage CKD[1]	
Dialysis	
Transplant	

[1]CKD: chronic kidney disease