SUPPLEMENTARY MATERIAL
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SUPPLEMENTARY RESULTS

Methodological Characteristics

Most included studies recruited children through hospitals (*n*=56, 81.2%), including emergency departments (*n*=19, 27.5%), inpatient admissions (*n*=33, 47.8%) and outpatient services (*n*=15, 21.7%). Thirteen studies recruited from both inpatient and outpatient services. The remaining studies recruited participants from community sports organizations and local schools (*n*=2, 2.9%), population cohort (*n*=3, 4.3%), or via existing research databases (*n*=2, 2.9%).

Definitions of concussion were provided by all studies. Four studies explicitly stated that their definition aligned the Berlin Consensus Statement on Concussion in Sport, while the remaining studies employed criteria consistent with this definition or reported outcomes for an uncomplicated concussion subgroup.

Key participant demographics were considered by several studies including socio-economic status (*n*=27), ethnicity (*n*=19), number of previous concussions (*n*=11), family functioning (*n*=5) and parent mental health (*n*=5).

SUPPLEMENTARY TABLES

Supplementary Table 1. Reported mental health outcomes, study characteristics and quality assessment of included studies

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Albicini et al. (2018)* [1]	Concussion (*n*=65), Orthopaedic Injury (n=43)	Longitudinal, between-subjects, cross-sectional	Hospital, ED	New Zealand	66%	0-17 years, 10.86 (4.87)	12.17 years (5.31) post-injury	Child	CIDI	Children with concussion reported significantly more psychiatric diagnoses than children with orthopaedic injuries with a moderate effect size.	13.5	Level 4
Anderson et al. (2001) [2]	Concussion (*n*=31)	Prospective, longitudinal, between-group	Hospital admissions to neurosurgical ward	Australia	67%	2-12 years, 9.3 (2.9)	6 months post-injury	Parent	RBRI, PIC	Behavioural functioning within the normal range pre- and post-concussion. Results showed slight but non-significant deterioration in behaviour scores post-injury.	16	Level 3
Anderson et al. (2005a) [3]	Concussion (*n*=10), TDC (*n*=26)	A prospective, longitudinal, between group	Hospital admissions to neurosurgical ward	Australia	50%	2-7 years, 4.6 (1.3)	30-months post-injury	Parent	PIC	While mean internalising and somatic symptoms increased over time, no significant differences in internalising problems were observed compared to TDC 30 months-post-concussion.	16	Level 3
Anderson et al. (2005b) [4]	Concussion (*n*=42)	Prospective, longitudinal, between group	Hospital admissions to neurosurgical ward	Australia	64%	3-12.11 years, 8.4 (3.0)	6- and 30-months post-injury	Parent	RBRI, PIC	Although there was some within group variation, post-injury behaviour was within the normal range and remained stable from 6-months to 30-months post-injury.	17.5	Level 3
Anderson et al. (2009) [5]	Concussion (*n*=40)	Retrospective cross-sectional	Hospital admissions to neurosurgical ward	Australia	70%	0-16 years, 10.19 (1.80)	2.5 years post-injury	Medical record	Service engagement	No differences were observed in psychiatric intervention between children with concussion and population data either acutely (17.5%) or in the long term (12.5%).	17.5	Level 3
Anderson et al. (2012a) [6]	Concussion (*n*=20)	Prospective, longitudinal, between group	Admission to paediatric hospital ED or neurosurgery ward	Australia	60%	2-12:11 years, 8.36 (3.08)	10 years post-injury	Parent	Service engagement	Children with concussion showed higher problem behaviors 10-years post injury than expected risk of impairment.	19	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Anderson et al. (2012b) [7]	Concussion (*n*=130)	Prospective, longitudinal, between group	Admission to paediatric hospital ED or neurosurgery ward	Australia	72%	6-14 years, 10.80 (2.42)	Pre-injury, 6 months post-injury	Parent	CBCL	Internalising, externalising and total behaviour problems were not significantly different before and after concussion. Pre-injury ratings significantly predicted post-concussion behavioural functioning.	18	Level 3
Anderson et al. (2020) [8]	Concussion (*n*=256)	Longitudinal prospective cohort study	Paediatric hospital ED	Australia	72%	5-18 years,	2 weeks, 3 months post-injury	Parent	CBCL	Children who recovered within 2 weeks demonstrated fewer internalising problems and lower rates of pre-injury psychiatric diagnoses than children with delayed recovery.	18	Level 3
Antshel et al. (2007)* [9]	Concussion (*n*=31), TDC (*n*=23)	Cross-sectional, between groups	Large urban academic medical center	USA	74%	6-11 years, 9:5 (1:9)	3 and 6 months	Parent & teacher	BASC	Despite similar ratings in behaviour problems 3 months post-injury, parents reported significantly more externalising problems 6 months post-injury than controls, as well as children with positive MRI findings. In the absence of MRI findings, parents were more likely to attribute externalising problems to be within their child's control, rather than attributed to the injury.	15.5	Level 3
Barker-Collo et al. (2007)* [10]	Concussion (*n*=40), Orthopaedic Injury (*n*=14)	Case control	ICU, neurology orthopaedic care units at a regional paediatric hospital	New Zealand	68%	3.8-13 years, 8.54 (3.52)	2-24 months, 7.22 (7.15) post-injury	Parent	CBCL	Behavioural problems fell within the normal range for concussion and control groups. Children with concussion exhibited lower scores on withdrawal, anxiety and depression compared with controls, resulting in a lower score on the internalising and total problem scores.	13.5	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Bellerose et al. (2015)* [11]	Concussion (*n*=51), TDC (*n*=50)	Prospective longitudinal cohort	ED	Canada	51%	1.5-5 years, 3.0 (0.9)	6.51 months, SD=0.83 post-injury	Parent	CBCL	Externalising behaviors were significantly higher in the concussion group than control group both pre-injury and 6 months post-concussion with a moderate effect size.	15	Level 3
Bernard et al. (2017)* [12]	Concussion (*n*=46), TDC (*n*=55)	Prospective longitudinal	ED	Australia	63%	2-12 years 11 months	<72 hours, 1 week, 1 month, 2 months, 3 months post-injury	Parent	CAB-P, CBI	Problematic behaviour significantly increased from pre-morbid levels in the concussion group compared with controls. Higher rates of premorbid post-concussive symptoms and the presence of premorbid learning difficulties were significant predictors of increased behavioural problems over time.	16.5	Level 3
Bloom et al. (2001) [13]	Concussion (*n*=15)	Retrospective exploratory study	Paediatric Hospital	USA	67%	6-15 years, m=9.9 (SD=4.4)	2.2 years post-injury	Child & parent	CDI, PIC, DICA-R	40% youth with concussion developed novel psychiatric disorders, 13.33% developed two or more novel psychiatric disturbances. Mean scores on the PIC-R were within the normal range.	13.5	Level 3
Bohorquez-Montoya 2020* [14]	Concussion (*n*=36), TDC (*n*=15)	Cross-sectional	Concussion clinic and community	USA	42%	14-18 years, 16.20 (1.07)	<3 months, 52 (6.97) days	Child	GAD-7, PHD-9, BSI, SHAPS	Children with delayed recovery after concussion reported more depression symptoms and psychological distress than recovered children and TDC. Anxiety was also significantly higher among children with delayed recovery compared with controls. Anhedonia was significantly higher among children with delayed recovery than recovered children after concussion.	13	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Botchway et al. (2019)* [15]	Concussion (*n*=14), TDC (*n*=13)	Prospective longitudinal design	Neurosurgical ward admissions, tertiary paediatric hospital	Australia	64%	0-12 years, 9.2 (2.9)	20 years post-injury	Child	DASS	High levels of post-concussion pain and anxiety significantly correlated with poorer sleep quality.	18	Level 3
Brooks et al. (2018)* [16]	Concussion (*n*=37), Orthopaedic Injury (*n*=16)	Prospective, multi-center cohort	Research databases	Canada	54%	8-19 years, 12.1 (2.7)	2.7 years post injury	Child & parent	BASC-2	Parents of youth with a history of concussion reported significantly worse anxiety and depression symptoms than parents of children with orthopaedic injury.	16	Level 3
Brooks et al. (2018) [17]	Concussion (*n*=275)	Cross-sectional	ED	Canada	65%	6-18 years, 11.6 (3.1)	4 weeks, 12 weeks post-injury	Parent	CBCL, SDQ	22.9% of children reported psychological distress at 4 weeks post-concussion and 23.2% at 12 weeks post-concussion. 60% of children with a history of anxiety or depression had elevated psychological distress at 4 weeks and 50% at 12 weeks. Among children without a history of anxiety or depression, 19.3% met the criterion for elevated psychological distress at 4 weeks and 20.5% at 12 weeks.	18	Level 3
Brown et al. (2016)* [18]	Concussion (*n*=116), TDC (*n*=5,414)	Prospective longitudinal Study	Three tertiary paediatric hospitals	Australia	69%	6-14 years, 10.44 (2.46)	3 months, 6 months, 12 months, 18 months post-injury	Parent	CHQ-PF50	Children with concussion showed clinically significant general behaviour problems compared with norms (3 months). Means fell within the normal range at subsequent time points (6 months). Older children demonstrated reduced functioning on behavioural and self-esteem subscales, but greater functioning on general behaviour.	14	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Bunt et al. (2020) [19]	Concussion (*n*=491)	Prospective	Specialized concussion clinics	USA	53%	12-18 years, 14.72 (1.64)	8.26 days (SD 5 7.30)	Child	GAD-7, PHQ-8	Females reported significantly higher levels of anxiety and depression in the days after concussion.	15.5	Level 3
Butler et al. (1997) [20]	Concussion (*n*=36)	Retrospective	Two large urban clinics and one large urban private practice	USA	UTD	6-16 years, 8.71 (3.4)	2.07 years post-injury	Parent	PIC-R	50% of children with concussion experience cognitive symptom profiles, while approximately 40% experience internalising symptoms and mild anxiety post-concussion.	12	Level 3
Catale et al. (2009) [21]	Concussion (*n*=15)	Use of a longitudinal design with follow-up assessment	Admissions to neuro-paediatric unit	Belgium	33%	6.7–11.5 years, M=8.3, SD=1.2	1-year post-injury	Parent	CPRS-R	Children's behavioural symptoms before concussion within the normal range for all factors considered. Results showed significantly more impulsive hyperactive symptoms after concussion compared with pre-injury functioning.	12	Level 3
Catroppa et al. (2012)* [22]	Concussion (*n*=40), Matched TCD (*n*=19)	Prospective longitudinal design	Hospital admission, tertiary paediatric hospital	Australia	43%	1.17-8.00 years, 4.81 (1.92)	10 years, 10.54 (1.57)	Parent	PIC, BASC	Externalising problems were significantly higher for the concussion group than for the control group. The concussion group showed a trend towards a higher percentage impaired for internalising problems and total behavioural symptoms.	17	Level 3
Crichton et al. (2017) [23]	Concussion (*n*=27)	Prospective longitudinal design	Hospital ED & ICU	Australia, Canada	85%	8-18 years, 13.3 (2.4)	6 weeks post-injury	Parent	CDI-2-P, CDI-2-SR, SCAS	Parent ratings of child depression was significantly associated with severe levels of fatigue.	18.5	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Crowe et al. (2012)* [24]	Concussion (*n*=20), TDC (*n*=27)	Cohort	Tertiary paediatric hospital ED and ICU	Australia	55%	1-35 months, 17.7 (10.7)	40 months post-injury	Parent	CBCL	Medium effect sizes were identified between the control and concussion group for emotionally reactive, withdrawn, and attention problems.	15	Level 3
Crowe et al. (2016) [25]	Concussion (*n*=10)	Prospective, longitudinal design	Local schools and sporting groups	Australia	70%	10-17 years, 14.6 (1.7)	30 days post-injury	Parent	CHQ	25.0% of parents rated their child as demonstrating post-concussion behaviour problems. Significant concerns were reported for 37.5% of cases for both mental health and family cohesion.	17.5	Level 2
Ellis et al. (2015) [26]	Concussion (*n*=174)	Retrospective chart review	Concussion clinic	Canada	62%	<19 years, 14.22 (2.34)	>1 month post-injury	Child	Psychiatric diagnoses	11.5% of children met the criteria for a psychiatric diagnoses post-concussion, including 8.0% with novel psychiatric diagnoses, 1.1% with isolated suicidal ideation, and 2.3% with worsening symptoms of a preinjury psychiatric disorder. Female sex, higher acute PCSS score, higher emotional PCSS index, preinjury psychiatric history, and family history of psychiatric illness were significantly associated with psychiatric outcomes.	14	Level 3
Fischer et al. (2018)* [27]	Concussion (*n*=11), Orthopaedic Injury (*n*=24), TDC (*n*=27)	Prospective longitudinal	Level 1 Paediatric Trauma centre	USA	64%	8-15 years, 12.2 (2.4)	Baseline, 6 months, 12 months post-injury	Parent	CBCL	Internalising problems were significantly higher after concussion compared with typically developing controls. No group differences in externalising problems observed between groups.	15	Level 3
Study	**N**	**Design**	**Setting**	**Country**	**Male**	**Age at Injury,**	**Assessed Timepoints**	**Report proxy**	**Mental Health**	**Main Mental Health Findings**	**DBC**	**OCEBM**

						Range, M (SD)			Measures			
Fletcher et al. (1990) [28]	Concussion (*n*=13)	Longitudinal	Paediatric neurosurgery services of two major university trauma hospitals	USA	62%	3-15 years, 8.6 (4.6)	Time of injury, 6 months, 12 months post-injury	Parent	CBCL	Scores on all scales were within the average range. No significant differences were found between scores at baseline, 6-months and 12-months post-concussion. No significant associations observed between CBCL scores and 75 cognitive variables.	16.5	Level 3
Gagner et al. (2018)* [29]	Concussion (*n*=86), TDC (*n*=81), Orthopaedic Injury (*n*=62)	Prospective longitudinal cohort	Tertiary care, paediatric ED	Canada	53%	1.3-5 years, 3.63 (0.98)	6 months post-injury	Parent	CBCL	There were significantly higher ratings of internalising and externalising behaviors in the concussion group than both control groups. In the concussion group, 38.4% of children had at least one clinically elevated score, compared with 25.8% in the orthopaedic injury group and 18.5% in the TDC group. There was a significant difference in this proportion between concussion and TDC groups, but not orthopaedic injury group.	18	Level 3
Gagner et al. (2020)* [30]	Concussion (*n*=85), TDC (*n*=82), Orthopaedic Injury (*n*=59)	Prospective longitudinal cohort	Tertiary care, paediatric ED	Canada	53%	1.3-5 years, 3.63 (0.98)	6, 18 and 30 months post-injury	Parent	CBCL	Children had significantly higher internalising and externalising problems 6 months post-injury compared with TDC, but not the orthopaedic injury group.	19	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Gornall et al. (2019)* [31]	Concussion (*n*=231), Orthopaedic Injury (*n*=11)	Prospective longitudinal cohort	Tertiary paediatric hospital ED	Australia	73%	5-<18 years, 11.7 years (3.1)	2 weeks, 3 months post-injury	Parent	CBCL	Children with concussion showed a significant improvement in behavioural functioning from 2-weeks to 3-months post-injury. As age increased, females were at increased risk for experiencing ongoing internalising problems 3 months after concussion.	18	Level 3
Gray et al. (2007) [32]	Concussion (*n*=22), Orthopaedic Injury (*n*=19)	Qualitative	Hospital ED	USA	59%	7-16 years, 10.00 (2.64)	0.88 years (0.28) post-injury	Parent	CBCL qualitative comments	Parents who endorsed high levels of after their child's concussion were most concerned about their child's poor school performance, lack of friends, inability to control angry feelings, apathy and problems with PTSD.	-	-
Guo et al. (2017) [33]	Concussion (*n*=105)	Prospective	Paediatric hospital admission	Australia	73%	6-14 years, 10.82 (2.44)	6 months post-injury	Child	CAPS-CA	Female sex, sustained attention and working memory functioning predicted poor PTSD outcomes 6-months post-concussion.	17	Level 3
Ho et al. (2018; 2020) [34, 35]	Concussion (*n*=30)	Single-site, cross-sectional investigation	Paediatric hospital, rehabilitation clinics, physician offices	Canada	33%	10-17 years, 13.8 (2.6)	5-8 weeks post-injury	Child & parent	CDI	36.7% of children experienced elevated depression following concussion.	15.5	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Kaldoja et al. (2012)* [36]	Concussion (*n*=35), matched TDC (*n*=70)	Prospective case-controlled study	Hospital	Estonia	63%	<5:5 years, 2.84 (1.66)	Pre-injury, follow-up 9 months post-injury	Parent	ASQ-SE	Children with concussion showed more pre-injury social-emotional difficulties compared to matched TDC. At follow-up, children with concussion showed more general social-emotional problems compared to TDC, with worsening social interaction problems over time.	16	Level 4
Keenan et al. (2018)* [37]	Concussion (*n*=144), Orthopaedic Injury (*n*=133)	Prospective cohort	Two level 1 paediatric trauma centres	USA	61%	2.5-15 years, 9.1 (4.3)	Pre-injury, 3 months, 12 months post-injury	Parent	CBCL, SDQ	Children with concussion had significantly higher scores on affective, anxiety, and ADHD subscales compared with the orthopaedic injury group. Children with concussion had decreasing symptoms over time. School-age children had high ADHD and affective symptoms scores, while pre-schoolers showed increasing symptoms over time. Females had significantly poorer functioning on all CBCL outcomes. A positive family environment was associated with better outcomes on all CBCL scales.	18	Level 3
Kenardy et al. (2012) [38]	Concussion (*n*=166)	Prospective longitudinal	Three tertiary paediatric hospitals	Australia	66%	6-15 years, 10.80 (2.42)	Pre-injury, 2 months, 3, 6, 12 months post-injury	Child	CBCL, CAPS-CA, CHQ-PF50	8% of the concussion group met PTSD diagnostic criteria. Children with PTSD showed significantly poorer psychosocial outcomes throughout the study period.	18	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Konigs et al. (2015)* [39]	Concussion (*n*=24), TDC (*n*=52)	Retrospective recruitment from consecutive cohort	Three university-affiliated level I trauma centres	The Netherlands	46%	6-13 years, 7.1 (2.4)	1.7 years post-injury	Parent & Teacher	CBCL	Children with concussion had more internalising problems according to teacher, but not parent report. No significant differences in internalising, externalising or attention problems were observed according to either parent and teacher report.	17	Level 3
Konigs et al. (2016)* [40]	Concussion (*n*=24), TDC (*n*=52)	Retrospective recruitment from consecutive cohort	Three university-affiliated level I trauma centres	The Netherlands	46%	6-13 years, 7.1 (2.4)	1.7 years post-injury	Parent & Teacher	CBCL	Internalising behaviour problems were significantly higher among children with concussion according to teachers. Nil other significant differences observed in internalising, externalising or attention problems according to either parent and teacher report.	18	Level 3
Kontos et al. (2012) [41]	Concussion (*n*=75)	Pretest, multiple posttest, repeated-measures	Institutions involved in concussion surveillance program	USA	74%	High School <18 years, 15.74 (1.28)	2-14 days post-injury	Child	BDI-II	Athletes reported significantly higher levels of depression symptoms from baseline at 2 days, 7 days, and 14 days post-concussion. There were no significant between-subject effects for age and sex on depression.	13	Level 3
Laliberté Durish et al. (2018)* [42]	Concussion (*n*=49), Orthopaedic Injury (*n*=26)	Cross-sectional	Research databases consisting of patients recruited from various clinics at a paediatric hospital	Canada	47%	8-18 years, 11.68 (2.83)	2.7 years (m=33.40 months, SD=19.59)	Child & parent	BASC-2, SDQ	Significantly more general behavioural problems, higher levels of anxiety and depression, and poorer quality of life reported in the concussion group compared with controls. Higher levels of resilience were associated with better behavioural functioning, fewer self-reported depressive symptoms and better quality of life.	15	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Lalonde et al. (2020) [43]	Concussion (*n*=68), TDC (*n*=76) Orthopaedic Injury (*n*=49)	Prospective longitudinal cohort	Urban tertiary care paediatric ED	Canada	56%	1.3-5 years, 3.49 (0.95)	6 months post-injury	Parent	CBCL	Child behaviour was not associated with parent-child interactions after concussion on any subscale. Socioeconomic status, child post-concussive symptoms, and child sleep problems significantly contributed to parent– child interactions.	17	Level 3
Luis et al. (2002)* [44]	Concussion (*n*=42) Orthopaedic Injury (*n*=35)	Prospective cohort	General Hospital admissions	USA	67%	6-15 years, 10.5 (3.3)	6 months post-injury	Child	DISC-IV, SRRQ	Children with concussion had significantly higher rates of novel diagnoses compared to the control group. Post-injury stress level and injury severity significantly predicted subsequent disorders.	14.5	Level 3
Massagli et al. (2004)* [45]	Concussion (*n*=490) TDC (*n*=1470)	Prospective cohort	ED (*n*=279), outpatient (*n*=191) and hospital settings (*n*=20)	USA	62%	<15 years, 0-4 years (n=129), 5-9 (n=161), 10-14 (n=200)	0-12 months, 12-24 months, 24-36 months post-injury	Medical records	Psychiatric Diagnoses	26% of children without a pre-morbid psychiatric history were diagnosed with a psychiatric illness after concussion. Evidence of any psychiatric illness during the 3-year follow-up was significantly higher among children with no psychiatric history after concussion compared with the control group. Psychiatric illness was estimated to occur in 55% of concussion patients and in 63% of controls (*p*=0.63) who had a prior psychiatric history.	15.5	Level 3

| Study | N | Design | Setting | Country | Male | Age at Injury, | Assessed Timepoints | Report proxy | Mental Health | Main Mental Health Findings | DBC | OCEBM |

						Range, M (SD)		Measures				
McKinlay et al. (2002)* [46]	Concussion (*n*=28) TDC (*n*=788)	Inception cohort	All hospital births in the region; inpatient and outpatient treated concussion	New Zealand	72%	<10 years old	Age 10, 11, 12, 13 (1-13 years post-injury)	Mother & teacher	RBRS, CBRS	Concussion inpatients showed increased attention and conduct problems than controls with medium to large effect sizes. After accounting for several demographic, family, and pre-injury characteristics, the inpatient but not the outpatient group displayed increased hyperactivity/inattention and conduct disorder between ages 10 to 13. Psychosocial deficits were more prevalent in the inpatient subgroup injured before age 5.	17.5	Level 2
McKinlay et al. (2009)* [47]	Concussion (*n*=76) TDC (*n*=839)	Inception cohort	All hospital births in the region; inpatient and outpatient treated concussion	New Zealand	53%	<5 years old	At age 14 to 16 years	Child, mother & teacher	DISC, SRED, RBPC	At age 14 to 16 years, children who had been hospitalized for concussion sustained in preschool years were significantly more likely to show symptoms of attention deficit/ hyperactivity disorder (OR=4.2), conduct disorder/oppositional defiant disorder (OR=6.2), substance abuse (OR=3.6), and mood disorder (OR=3.1) but not anxiety disorder.	17.5	Level 2
McKinlay et al. (2010)* [48]	Concussion (*n*=81), TDC (*n*=831), Orthopaedic injury (*n*=20)	Inception cohort	All hospital births in the region; inpatient and outpatient treated concussion	New Zealand	51%	<10 years old	Age 10, 11, 12, 13 (1-13 years post-injury)	Mother & teacher	RBRS, CBRS	Higher rates of ADHD, oppositional disorder and conduct disorder problems among children hospitalized for concussion, compared to children who attended outpatient services post-concussion and control group. The inpatient concussion group showed increasing behavioural difficulties over time.	16	Level 2

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
McKinlay et al. (2014)* [49]	Concussion (*n*=58), Orthopaedic injury (*n*=38)	Longitudinal cohort	Audit of neurosurgical files, ED and admission records, and community	New Zealand	53%	0-17 years, 7.1 (4.0)	>5 years post-injury	Child report	EBS	Children with concussion reported more problems with malevolent aggression, but not social anxiety or self-esteem compared with orthopaedic controls.	15	Level 3
O'Connor et al. (2012)* [50]	Concussion (*n*=120) Orthopaedic Injury (*n*=39)	Prospective cohort	One Level 1 trauma centre, four Level 3 or 4 trauma centres and four non-trauma centre hospitals	USA	71%	14-17 years, 15.88 (0.93)	5 weeks, 3 months, 12 months and 24 months post-injury	Child & parent	PHQ, UCLA PTSD Reaction Index for DSM-IV-R	Children with concussion reported significantly worse PTSD symptoms across time compared to the control group. Greater levels of PTSD symptoms were associated with poorer school and physical functioning. Greater depressive symptoms were associated with poorer school functioning.	18	Level 3
Plourde et al. (2018)* [51]	Concussion (*n*=48) Orthopaedic Injury (*n*=27)	Cross-sectional	Tertiary care paediatric hospital	Canada	46%	8-19 years, 11.61 (2.72)	>12 months, 35.92 months post-injury	Child	BASC-2, SDQ	No significant differences were observed on long-term psychosocial functioning between groups. Pre-existing mood concerns and attention problems significantly predicted psychosocial adjustment post-concussion.	17	Level 3
Plourde et al. (2019) [52]	Concussion (*n*=33)	Cross-sectional	ED	Canada	49%	9.5-18.6 years, 4.9 (2.4)	15.5-31.2 months post-injury, 22.8 (5.6),	Child & parent	BASC-2, C-DISC-IC	18.2% of participants and parents reported at least mild post-concussion anxiety, while 6.5% met diagnostic criteria for generalized anxiety disorder. 9.1-12.1% reported depressive symptoms, with 6.5% meeting criteria for a major depressive episode.	14.5	Level 3

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Renstrom et al. (2012)* [53]	Concussion (*n*=13), TDC (*n*=229)	Case-control retrospective design	University Hospital Department of Paediatrics, neurosurgery, neurorehabilitation, surgery & orthopaedics	Sweden	60%	7-18 years, 12.9 years (3.1)	4.7–8.6 years post-injury, 6.8 (1.1)	Child	SF-36	The concussion group showed lower but non-significant mental health outcomes compared with the control group. Nearly half of the participants with concussion reported that their life situation was negatively influenced by the concussion including problems with finding jobs, affected school results and difficulties in everyday living.	12	Level 4
Rockhill et al. (2010)* [54]	Concussion (*n*=490), TDC (*n*=1470)	Prospective cohort	Large HMO	USA	62%	<15 years, 0-4 years (n=129), 5-9 (n=161), 10-14 (n=200)	3 years post-injury	Healthcare provider	ICD-9 Codes	28% of children experienced psychological distress in the 3 years after concussion, compared with 18% of TDC (OR=1.71). Presence of psychological distress was also associated with increased costs in all categories examined and was associated with an approximate doubling of mean total costs.	17.5	Level 3
Rosema et al. (2015)* [55]	Concussion (*n*=13) TDC (*n*=20)	Prospective, longitudinal	Neurosurgical Ward, tertiary paediatric hospital	Australia	59%	1-7 years 11 months, 4.59 (1.64)	Acute, 6 months, 5, 10- and 16-years post-injury	Parent	PIC, ABCL, PIC	The concussion group showed significantly higher levels of internalising and externalising symptoms between six months and 10 years post-injury. Mean levels internalising and externalising symptoms for both groups fell within the average range.	17	Level 3

| Study | N | Design | Setting | Country | Male | Age at Injury, | Assessed Timepoints | Report proxy | Mental Health | Main Mental Health Findings | DBC | OCEBM |

						Range, M (SD)			Measures			
Ryan et al. (2015) [56]	Concussion (*n*=15)	Longitudinal prospective	Paediatric hospital emergency department	Australia	53%	1-12 years, 7.89 (3.68)	16 years post-injury	Significa nt other	ABCL	20% of the concussion group showed clinical or subthreshold levels of externalising symptoms 16 years post-injury. Clinical or subthreshold levels of externalising problems were not associated with injury severity but were, instead equally apparent across young adults with TBI of all severity levels.	18	Level 3
Ryan et al. (2016)* [57]	Concussion (*n*=13) TDC (*n*=33)	Longitudinal	Hospital	Australia	75%	5.3-15.4 years, 10.69 (2.35)	24 months post-injury	Parent	CBCL	No significant differences observed between concussion and TDC groups on total behaviour problems.	15	Level 3
Ryan et al. (2019) [58]	Concussion (*n*=15)	Prospective cohort	Hospital admissions	Australia	53%	1-12 years, 7.23 (3.5)	15 years post-injury	Child	GHQ	Depression symptoms post-injury predicted psychological quality of life 15 years postinjury.	18	Level 3
Sariaslan et al. (2016) [59]	Concussion (*n*=80,676), TDC (*n*=1,039, 180)	Inception cohort	Population Cohort	Sweden	61%	0-25 years, 12.2 (0.02)	Lifetime prevalence post-injury	Clinician	Hospital records	Risk of psychiatric visit and psychiatric hospitalization were 31% and 52% higher in the concussion group compared with family members who did not sustain a TBI and adjusting for sex, birth order, birth year, individual and parental education, income, parental lifetime criminal and psychiatric histories and maternal single status	18	Level 2
Study	**N**	**Design**	**Setting**	**Country**	**Male**	**Age at Injury, Range, M (SD)**	**Assessed Timepoints**	**Report proxy**	**Mental Health Measures**	**Main Mental Health Findings**	**DBC**	**OCEBM**

Schachar et al. (2004)* [60]	Concussion (*n*=65) TDC (*n*=57)	Historical cohort	Several large, urban paediatric hospitals	USA	59%	0.4-13.7 years, 6.1 (3.3)	>2 years post-injury, 5.1 (2.1)	Parent & Teacher	SDI	Secondary ADHD symptoms and diagnoses significantly higher in concussion group compared with controls. No significant differences in anxiety symptoms or diagnoses post-concussion.	11.5	Level 3
Scott et al. (2015)* [61]	Concussion (*n*=61) Orthopaedic injury (*n*=43)	Cohort	Audit of neurosurgery files, ED admissions and community notices	New Zealand	54%	1-17 years, 7.1 (4.0)	15.1 (4.7) years post-injury	Child	CIDI	The concussion group showed significantly more anxiety disorder diagnoses and substance abuse disorders compared with controls. Depression and offending were twice as prevalent in the concussion group. Anxiety disorders were three times more prevalent in females, whilst offending behaviour and substance abuse/dependence was 4-5 times higher in males after concussion.	13.5	Level 3
Smyth et al. (2014) [62]	Concussion (*n*=89)	Cross-sectional	Research databases	Canada	65%	0-18 years, 13.8 (3.2)	1.73 years post-injury	Child	CDI	Depression scores in the symptomatic and asymptomatic concussion groups did not differ significantly. 3% of children with concussion had clinically significant depression symptoms. Age and stressful life events showed a significant difference between groups. After controlling for the effects of age, the stressful life events score was a significant predictor of being symptomatic after concussion.	15	Level 3
Study	**N**	**Design**	**Setting**	**Country**	**Male**	**Age at Injury, Range, M (SD)**	**Assessed Timepoints**	**Report proxy**	**Mental Health Measures**	**Main Mental Health Findings**	**DBC**	**OCEBM**

Study	N	Design	Setting	Country	Male	Age at Injury, Range, M (SD)	Assessed Timepoints	Report proxy	Mental Health Measures	Main Mental Health Findings	DBC	OCEBM
Stojanovski et al. (2019)* [63]	Concussion (*n*=418) Orthopaedic Injury (*n*=3193)	Retrospective population cohort	Population Cohort	USA	61%	8-22 years, 14.4 (3.4)	UTD	Child & parent	GOASSESS	Children with concussion had a significantly higher ADHD symptom severity score compared with children with other injuries (p=0.002).	14	Level 2
Taylor et al. (2015)* [64]	Concussion (*n*=56) Orthopaedic injury (*n*=41)	Cohort	Audit of ED admissions, neuro-surgery files, community recruitment	New Zealand	50%	0-18 years, 6.7 (4.0)	>5 years post-injury	Child	DSMIV-TR Structured Interview	Small, non-significant increase in Major Depressive Disorder diagnoses were observed in the concussion group compared with the orthopaedic control group.	16	Level 3
Theadom et al. (2016)* [65]	Concussion (*n*=68) TCD (*n*=68)	Longitudinal study with an embedded case control study	Hospital & ambulance records, school and sports clubs, general practitioner, allied health service referrals, and self-referral	New Zealand	60%	8-16 years, 10.5 (2.1)	1-year post-injury	Child & parent	BASC-2	Significantly higher internalising and externalising behaviour problems 1-year after concussion, compared with the control group. Sleep quality was significantly associated with externalising behaviour (p<0.01) while age, sleep quantity and pain were significantly associated with internalising behaviour (p<0.01 for all comparisons).	16	Level 2
Truss et al. (2017) [66]	Concussion (*n*=120)	Prospective longitudinal cohort	Paediatric hospital emergency department	Australia	63%	5-18 years, 12.0 (2.4)	2 weeks, 1 month, 3 months post-injury	Child	CPSS	16% of children had clinically significant post-traumatic symptoms 2-weeks post-concussion, declining to 10% at 1 month and 6% at 3 months post-injury. Group-based trajectory modelling identified three trajectories of post-traumatic stress symptoms post-concussion ‘‘resilient’’ (70%); ‘‘recovering” (25%) and ‘‘chronic symptomatology” (5%).	13.5	Level 3

Valovich McLeod et al. (2017) [67]	Concussion (*n*=12)	Qualitative	Secondary Schools	USA	67%	13-18 years, 15.7 (1.7)	13-20 days, follow-up in first 2 months post-injury	Child	Qualitative semi-structured interview	Participants reported increased emotional symptoms, including irritability, sadness, depression, and anxiousness post-concussion, and felt that this affected their school and social roles. Participants described trying to minimize or mask concussion symptoms to avoid being viewed differently by peers.	-	-
Wilmoth et al. (2019) [68]	Concussion (*n*=141)	Prospective	Outpatient clinics participating in regional concussion registry	USA	54%	12-18 years, 15.0 (1.6)	2 weeks, 3 months post-injury	Child	GAD-7, PHQ	The GAD-7 significantly predicted delayed recovery, with a 1.4-fold increased risk for every point.	14	Level 3
Yang et al. (2016)* [69]	Concussion (*n*=3,605), TDC (*n*=41,664), OI (*n*=2,179)	Inception cohort	Population cohort	Taiwan	60%	≤12 years, 5:7 (3:4)	9-year cumulative incidence, median=4.5 8 years post-injury	Clinician	Diagnosis of ADHD	Children with concussion had a 1.3-fold increased risk of ADHD (95% CI = 1.10, 1.53)	17.5	Level 2

*Study included in meta-analysis.

Abbreviations: Ages and Stages Questionnaire – Social and Emotional Index (ASQ-SE); Behaviour Assessment System for Children (BASC); Brief Symptom Inventory (BSI); Child Behaviour Checklist (CBCL); Child Depression Inventory (CDI); Child Health Questionnaire (CHQ); Child PTSD Symptom Scale (CPSS); Composite International Diagnostic Interview (CIDI); Clinician-Administered PTSD Scale (CAPS-CA); Connors Behaviour Rating Scale (CBRS); Depression, Anxiety and Stress Scale (DASS); Downs and Black Criteria (DBC); Diagnostic Interview Schedule for Children (DISC); Diagnostic Interview for Children and Adolescents-Revised (DICA-R); Emergency Department (ED); Generalized Anxiety Disorder Screener (GAD-7); International Classification of Diseases, Ninth Edition (ICD-9); Patient Health Questionnaire (PHQ); Personality Inventory for Children (PIC); Snaith-Hamilton Pleasure Scale (SHAPS); Self-Report Early Delinquency scale (SRED); Social Readjustment Rating Questionnaire (SRRQ); Revised Behaviour Problems Checklist (RBPC); Rowe Behavioural Rating Inventory (RBRI); Rutter Children Behaviour Questionnaire (RCBQ); Short Form 36 Health Survey (SF-36); Spence Anxiety Scales (SAS); Spence Children's Anxiety Scale (SCAS); and Survey Diagnostic Inventory (SDI); Typically developing control (TDC).

Supplementary Table 2. Subgroup analyses of internalising and externalising difficulties after paediatric concussion

	Persisting			Chronic		
	Q	*df*	*p*	*Q*	*df*	*p*
Internalising						
OCEBM	0.31	1	0.57	7.15	2	0.03*
Data type	0.95	2	0.62	8.87	2	0.01*
Control group	0.26	2	0.88	4.2	2	0.12
Pre-injury psychiatric exclusion	0.43	1	0.51	0.18	1	0.67
Measure type	4.98	2	0.08	1.18	2	0.55
Externalising						
OCEBM	0.83	1	0.36	1.35	1	0.24
Data type	4.08	2	0.12	1.29	2	0.53
Control group	2.30	3	0.51	1.01	2	0.60
Pre-injury psychiatric exclusion	0.72	1	0.40	0.43	1	0.51
Measure type	2.51	1	0.11	7.66	2	0.02*

Supplementary Table 3. Meta-regression of internalising and externalising difficulties after paediatric concussion

	Persisting			Chronic		
	R^2	*F*	*p*	R^2	*F*	*p*
Internalising						
Mean age (years)	0.00	0.06	0.81	0.00	0.36	0.56
Sex (% male)	0.00	0.06	0.81	0.06	1.25	0.29
Pre-injury mental health	0.16	0.96	0.36	-	-	-
Pre-injury psychiatric exclusion	0.00	0.48	0.50	0.00	0.41	0.53
DBC	0.00	0.08	0.79	0.08	1.52	0.24
Externalising						
Mean age (years)	0.00	0.14	0.72	0.05	1.72	0.22
Sex (% male)	0.00	0.38	0.55	0.00	0.84	0.38
Pre-injury mental health	-	-	-	-	-	-
Pre-injury psychiatric exclusion	0.08	1.36	0.33	0.00	0.29	0.60
DBC	0.00	0.00	0.99	0.00	0.97	0.35

Supplementary Table 4. Search strategy for Medline.

Set	*Search Statement*
1.	brain injuries/ or brain injuries, traumatic/ or brain concussion/
2.	exp Head Injuries, Closed/
3.	concuss*.tw,kf.
4.	((mild or minor) adj3 (brain or traumatic or tbi)).tw,kf.
5.	mtbi.tw,kf.
6.	1 or 2 or 3 or 4 or 5
7.	mood disorders/ or mental disorders/ or mental health/ or child behaviour disorders/ or conversion disorder/ or psychological trauma/ or stress disorders, post-traumatic/ or stress disorders, traumatic, acute/ or "Quality of Life"/
8.	anxiety disorders/ or anxiety/
9.	(anxious or anhedonia or apathy or shy* or (social adj adjustment) or (social adj isolation) or (psychological adj stress) or depress* or (affective adj symptom*) or (emotional adj adjustment) or melanchol* or internali#ing or internali#e*).tw,kf.
10.	(mental adj illness).tw,kf.
11.	depressive disorder/ or depression/ or depressive disorder, major/
12.	exp "attention deficit and disruptive behaviour disorders"/
13.	7 or 8 or 9 or 10 or 11 or 12
14.	(boy*1 or girl*1 or child* or adolescen* or juvenile or teen* or youth*1 or pediatric* or paediatric* or preschool or pre-school or infant).af.
15.	6 and 13 and 14
16.	limit 15 to (case reports or comment or editorial or letter or "review")
17.	15 not 16
18.	exp animals/ not human*.sh.
19.	17 not 18
20.	limit 19 to (english language and yr="1980 -Current")

Supplementary Table 5. Search strategy for Embase & Embase Classic.

Set	*Search Statement*
1.	concussion/ or brain concussion/ or traumatic brain injury/ or brain injury/ or acquired brain injury/
2.	((closed adj head adj injur*) or concuss* or mtbi).tw,kw,dq.
3.	((mild or minor) adj3 (brain or traumatic or tbi)).tw,kw,dq.
4.	1 or 2 or 3
5.	minor depression/ or "mixed anxiety and depression"/ or depression assessment/ or depression/ or major depression/
6.	anxiety disorder/ or anxiety/ or posttraumatic stress disorder/ or psychotrauma/
7.	mood disorder/ or mental health/ or "psychological well-being"/ or mental disease/ or "quality of life"/
8.	(anxious or anhedonia or apathy or shy* or (social adj adjustment) or (social adj isolation) or (psychological adj stress) or depress* or (affective adj symptom*) or (emotional adj adjustment) or melanchol* or internali#ing or internali#e* or externali#ing or externali#e).tw,kw,dq.
9.	(mental adj illness).tw,kw,dq.
10.	attention deficit disorder/ or behavior disorder/
11.	somatoform disorder/ or conversion disorder/
12.	5 or 6 or 7 or 8 or 9 or 10 or 11
13.	(boy*1 or girl*1 or child* or adolescen* or juvenile* or teen* or youth*1 or paediatric* or pediatric* or preschool or pre-school or infant*).af.
14.	4 and 12 and 13
15.	adolescent depression/
16.	4 and 15
17.	14 or 16
18.	limit 17 to (editorial or letter or "review")
19.	17 not 18
20.	exp animal/ not human*.sh.
21.	19 not 20
22.	(depressed adj1 (skull or fracture)).tw,kw,dq.
23.	21 not 22
24.	limit 23 to (english language and yr="1980-Current")

Supplementary Table 6. Search strategy for PsycInfo

Set	*Search Statement*
1.	Brain Concussion/ or Traumatic Brain Injury/ or head injury/ or brain injury/
2.	(concuss* or (closed adj head adj injur*)).ti,ab,id.
3.	((mild or minor) adj3 (brain or traumatic or tbi)).ti,ab,id.
4.	mtbi.ti,ab,id.
5.	1 or 2 or 3 or 4
6.	affective disorders/ or mental disorders/ or adjustment/ or emotional disturbances/ or emotional states/ or coping behavior/ or behavior problems/ or somatoform disorders/ or conversion disorder/ or emotional disturbances/ or Posttraumatic Stress Disorder/ or Emotional Trauma/ or Psychological Stress/ or Attention Deficit Disorder/ or "well being"/ or "quality of life"/
7.	internalization/ or externalization/
8.	MAJOR DEPRESSION/ or "DEPRESSION (EMOTION)"/
9.	ANXIETY DISORDERS/ or ANXIETY/
10.	(anxious or anhedonia or apathy or shy* or (social adj adjustment) or (social adj isolation) or (psychological adj stress) or depress* or (affective adj symptom*) or (emotional adj adjustment) or melanchol* or internali#ing or internali#e* or externali#ing or externali#e*).ti,ab,id.
11.	6 or 7 or 8 or 9 or 10
12.	(boy*1 or girl*1 or child* or adolescen* or juvenile* or teen* or youth*1 or paediatric* or pediatric* or preschool or pre-school or infan*).af.
13.	5 and 11 and 12
14.	limit 13 to ("comment/reply" or editorial or letter or review-book or review-media or reviews)
15.	13 not 14
16.	exp animals/ not human*.sh.
17.	15 not 16
18.	(depressed adj1 (skull or fracture)).ti,ab,id.
19.	17 not 18
20.	limit 19 to (english language and yr="2020 -Current")

Supplementary Table 7. Articles retrieved by database

Database	*Articles Retrieved*
OVID - MEDLINE	1,628
OVID - EMBASE	3,203
OVID - PsycINFO	1,903
EBSCO - CINAHL	273
EBSCO - SPORTDiscus	19
Scopus	4,518
PubMed	739
Total	12,283

SUPPLEMENTARY FIGURE LEGENDS

Figure 1. Standard mean difference of acute, persisting, and chronic internalising problems after paediatric concussion omitting outliers.

Figure 2. Standard mean difference of acute, persisting, and chronic externalising problems after paediatric concussion omitting outliers.

Figure 3. Standard mean difference of acute, persisting, and chronic total problems after paediatric concussion omitting outliers.

Figure 4. Persisting and chronic internalising problems after paediatric concussion by design.

Figure 5. Persisting and chronic externalising problems after paediatric concussion by design.

Figure 6. Persisting and chronic internalising problems after paediatric concussion by respondent.

Figure 7. Persisting and chronic externalising problems after paediatric concussion by respondent.

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