Table 1: Search Strategy Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present

#	Searches	#	Search continued
1	exp brain concussion/	29	medication*.tw.
2	exp post-concussion syndrome/	30	therapy.tw.
3	(sport* adj2 concussion*).tw.	31	rehabilitation.tw.
4	mild traumatic brain injur*.tw.	32	exercis*.tw.
5	exp Craniocerebral Trauma/	33	pharmacotherapy.tw.
6	mtbi.tw.	34	brain training.tw.
7	traumatic brain injur*.tw.	35	cognitive behavioral therapy.tw.
8	concussion*.tw.	36	cognitive behavioural therapy.tw.
9	(sport* adj2 head trauma).tw.	37	mindfulness.tw.
10	or/1-9	38	cognitive therapy.tw.
11	exp rest/	39	neurorehabilitation.tw.
12	rest.tw.	40	training.tw.
13	resting.tw.	41	physiotherapy.tw.
14	cognitive rest.tw.	42	physical therapy.tw.
15	exp therapeutics/	43	treatment.tw.
16	exp treatment outcome/	44	management.tw.
17	exp rehabilitation/	45	or/11-44
18	exp exercise therapy/	46	exp Sports/
19	exp exercise/	47	sport*.tw.
20	exp drug therapy/	48	exp Athletes/
21	exp cognitive therapy/	49	athlete*.tw.
22	cognitive rehabilitation.tw.	50	athletic*.tw.
23	visual therapy.tw.	51	player*.tw.
24	vision therapy.tw.	52	or/46-51
25	exp physical therapy modalities/	53	10 and 45 and 52
26	vestibular therapy.tw.	54	limit 53 to english language
27	rh.fs.	55	remove duplicates from 54
28	dt.fs.		

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Table 2: MEDLINE Search Strategy

Concussion Terms	Rest / Treatment Terms	Sport Terms
Brain concussion (MeSH) OR Post-Concussion syndrome (MeSH) OR sport* adj2 concussion* OR mild traumatic brain injur* OR Craniocerebral trauma (MeSH) or mtbi OR traumatic brain injur* OR concussion* OR sport* adj2 head trauma	Rest (MeSH) OR rest OR resting OR cognitive rest OR therapeutics (MeSH) OR treatment outcome (MeSH) OR rehabilitation (MeSH) OR exercise therapy (MeSH) OR exercise (MeSH) OR drug therapy (MeSH) OR cognitive therapy (MeSH) OR cognitive rehabilitation OR visual therapy OR vision therapy OR physical therapy modalities (MeSH) OR vestibular therapy OR rh.fs. OR dt.fs. OR medication* OR therapy OR rehabilitation OR exercise* OR pharmacotherapy OR brain training OR cogntivie behavioral therapy OR cognitive behavioural therapy OR mindfulness OR cognitive therapy OR neurorehabilitation OR training OR physiotherapy OR physical therapy OR treatment OR management	Sports (MeSH) OR sport* OR athletes (MeSH) OR athlete* OR athletic* OR player*

MeSH terms were exploded to include more specific terms
MeSH terms were translated into the appropriate subject headings for other databases
Keywords were the same for each database searched

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Online Supplementary Table 3. Summary of studies on rest, treatment, and rehabilitation following sport-related concussion.

From: Schneider, K.J., Leddy, J.J., Guskiewicz, K. M., Seifert, T., McCrea, M., Silverberg, N.D., Feddermann-Demont, N., Iverson, G.L., Hayden, K.A., & Makdissi, M. Rest and Specific Treatments Following Sport-Related Concussion: A Systematic Review. *British Journal of Sports Medicine*.

Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
Rest					
Brown et al, 2014, USA Prospective Cohort	n = 335, age (range 8-23; mean = 15±2.6 years), male n = 208 (62%)/female n=127 (37%) Definition: Concussion as defined in McCrory et al. Consensus statement on concussion in sport—the 4th International Conference on Concussion in Sport held in Zurich, November 2012	Athletes reported their cognitive activity level (0-4 scale) at each follow-up visit. Cognitive activity-days were then calculated by multiplying the average cognitive activity level reported by the patient by the days between visits. No information is given on discharge guidelines for athletes (e.g., increased rest or graduated return to play/school)	Athletes were considered recovered when (1) they were symptom-free at rest, (2) they were symptom-free with exertion and after discontinuing medications prescribed for post-concussion symptoms, (3) their balance error symptom scores were back to baseline, when available, and (4) their computerized neurocognitive test scores were at or above baseline values, when available. Symptom-free was defined as a post-concussion symptom score of 0. Duration of post-concussion symptoms was used as the primary outcome. The duration of post-concussion symptoms was defined as the time between the date of injury and the athlete's last date of symptoms, which was queried at each clinic visit.	The overall mean duration of symptoms was 43±53 days. Only total symptom burden at initial visit [Hazard Ratio 0.980 (95% CI; 0.973-0.986)] and cognitive activity level [Hazard Ration=0.994 (95% CI;0.992-0.996)] were independently associated with duration of symptoms. Increased cognitive activity was associated with longer recovery from concussion.	Bias: 10 Evidence: 3
Moser et al, 2012, USA Retrospective Case Series	n = 49, age (range = 14-23; mean = 15±2.58 years), 33 males and 16 females	One full week of rest (cognitive and physical), prior to returning for a follow-up examination and	Post-Concussion Symptom Scale ratings and scores on the 4 composite indices of	Participants showed significantly improved performance on Immediate	Bias: 10 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	Definition of concussion: Concussion as defined in McCrory et al, 2009.	re-testing.	the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), both before and following rest.	Post-Concussion Assessment and Cognitive Testing and decreased symptom reporting following prescribed cognitive and physical rest [F(5.4) = 10.6; p = .001], regardless of the time between concussion and onset of rest (p = .44). PCSS score decreased from 22.0-28.1 to 3.8-11.4 depending on time since injury.	
Moser et al, 2015; USA Retrospective Case Series	n = 13, age (range 12-17; mean 15.1±1.5 years), male/female = 57%/43% Concussion Definition: No explicit reference or definition	One week of cognitive and physical rest. At the time of the initial evaluation at the clinic, a list of cognitive and physical activities to be avoided was provided to the parents of athletes to help monitor rest compliance. Low exertion activities were recommended. Athletes were advised to avoid activities that might produce a sweat or exacerbate symptoms.	Time (Time 1: post-concussion, school or external facility, pre-specialty clinic; Time 2: post-concussion, before rest, at specialty clinic; Time 3: after 1 week of prescribed rest, at specialty clinic) as the independent variable and the four ImPACT cognitive composite scores (verbal memory, visual memory, visual motor speed, reaction time) and Post-Concussion Symptom Scale scores as the dependent variables.	Following prescribed rest, having two or more reliably improved cognitive test scores or having improved symptoms was present in eight of the 13 patients (61.5%).	Bias: 13 Evidence: 4
Gibson et al, 2013; USA Retrospective Cohort Study	n = 184, age (range 8-26, mean±SD = 15±3 years), 133 male (72%), 51 female (28%) Concussion Definition: Concussion as defined in McCrory et al., 2009	Recommendation of cognitive rest explicitly stated in medical record.	Post-Concussion Symptom Scale (PCSS) symptoms at 30 days	85 (63%) patients were recommended cognitive rest. Of those, 79 (59%) had prolonged symptoms > 30 days. In the multivariate analysis, only initial PCSS score was associated with the duration of concussion symptoms adjusted odds ratio (AOR)=1.03; 95%	Bias: 7 Evidence: 3

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
				CI=1.01–1.05). The recommendation for cognitive rest was not significantly associated with time to concussion symptom resolution (AOR=0.5; 95% CI=0.18–1.37).	
Howell et al, 2016; USA Prospective Cohort study	n = 364, age (range 8-27, mean±SD = 15±2.8 years), male n=222 (61%); female n=142 (39%); mean time since injury = 11.8±5.4 days. Definition: Concussion as defined in McCrory et al., 2013	Physical Activity: (adapted from return to play protocol): 1=rest, 2=minimal athletic activity; 3=moderate athletic activity; 4=sport-specific activity; 5=noncontact activity; 6=full practice with contact; 7=game play. Cognitive activity: Using the 0-4 Cognitive Activity Scale (Brown et al, 2014)	The main outcome variable, was symptom duration on the Post-Concussion Symptom Scale (PCSS), defined as the time (days) between the day of injury and the last day of symptoms.	Mean PCSS severity score at initial presentation was 34.7±25.7. The mean symptom duration was 48.9±76.0 days after the injury. Physical activity level after injury was not associated with symptom duration. Initial PCSS score and female sex were independently associated with symptom duration. Higher levels of physical activity after the injury were associated with a shorter symptom duration for 13-18 year olds.	Bias: 7 Evidence: 3
Moor et al, 2015; USA Prospective Cohort study	n = 111 total enrolled; 56 returned questionnaires (50.5%), age (range 12.6-19.6, mean±SD = 15.2±1.7 years), male/female 54/46% Definition: Diagnosis of SRC and evaluated at the Akron Children's Hospital Sports-Medicine Center	For each patient, the treatment recommendations that were provided to the patient over their course of care were recorded. Participants completed a survey regarding adherence to physician rest recommendations.	Number of days of treatment (date of full contact return to play minus the date of the initial assessment at the Sports Medicine Centre) + qualitative interviews	All participants were recommended physical rest. 71% were receptive to this recommendation and 88% reported following the recommendation most of the time. None of the measures of adherence to the treatment recommendations were significant predictors of the number of days of treatment and return to play.	Bias: 7 Evidence: 3
Corwin et al., 2014, USA, Retrospective Cohort Study	n = 247, age mean = 14, range = 5-18; sex 42% female Definition: ICD-9 code	Recommendation for cognitive rest by referring provideer.	Time to return to return to school, symptom-free, fully cleared to return to sports; Pre-existing conditions	One half of patients were recommended cognitive rest. Referral for cognitive rest was not predictive or	Bias: 10 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	diagnosis of concussion subsequently confirmed by sports medicine physician as per McCrory et al, 2013.		(depression, anxiety, attention deficit hyperactivity disorder, learning disability); Patient or parent reported presenting symptoms; Physical examination (symptom provocation on oculomotor exam, abnormal near point convergence >6cm); patient age; patient or parent previous concussion history; patient or parent self report of prescribed rest from referring provider	associated with time to return to school, time to becoming symptom-free or until being fully cleared.	
Eisenberg et al., 2013; USA, Prospective Cohort Study	n = 235/280, age mean = 14.3, sex = 135 (57%) male; 100 (43%) female Definition: A blunt injury to the head resulting in either: 1) alteration in mental status or 2) any of the following symptoms that started within 4 hours of injury and were not present before the injury: headache, nausea, vomiting, dizziness/balance problems, fatigue, drowsiness, blurred vision, memory difficulty or difficulty concentrating.	Advised cognitive rest or physical rest at time of presentation to ED.	Time to symptom resolution (within 90 days) via Rivermead Post-concussion Symptoms Questionnaire (RPSQ)	Prescription of cognitive or physical rest was not predictive of a longer time to symptom resolution.	Bias: 18 Evidence: 4
Thomas et al, 2015 USA, Randomized Controlled Trial	n = 99, age median (IQR) =13.7 (12.4-15.0); 34 females Definition: Mild Traumatic Brain injury/concussion using the Acute concussion Evaluation (ACE) form	Strict rest (intervention group): Recommendation from treating physician to maintain 5 days of strict rest at home (no school, work or physical activity) followed by a stepwise return to activity. Usual care (control	Three-Day Activity Diary; Seven-Day Activity Diary; 19 – symptom Post-Concussive Symptoms Scale (PCSS); Immediate Post Concussion Assessment and Cognitive Testing (ImPACT); Balance	88/99 completed follow-up. Both groups reported a 20% decrease in physical activity level and energy expenditure in the first 5 days post injury. Usual care group performed more high and moderate	Bias: 21 Evidence: 2

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
		group): Treating physician verbally recommended activity restrictions as they saw fit.	Error Scoring System (BESS)	mental activity days 2-5. (8.33 control vs 4.86 intervention, p = 0.03). No difference was identified in neurocognitive or balance outcomes. More daily postconcussive symptoms were reported in the strict rest group (Total symptom score over 10 days 187.9 vs 131.9, p<0.03).	
Treatment - Rehabilitation					
McCarty et al, 2016, USA. Randomized Controlled Trial	n=49 patients with persistent symptoms ≥ one month after a sport-related concussion; Age: 11-17 years; 65% female (n=32) and 35% male (n=17) Definition: Diagnosis by sports medicine or rehabilitation medicine specialist	Intervention: Collaborative care that included care management (including advocacy and coordination with school regarding accommodations and motivational interviewing), cognitive behavioural therapy (CBT), and possible psychopharmacological consultation. Average of 6.2 (SD=4.6) concussion-related visits. Control: Care as usual which included baseline and follow-up assessments at 1, 3, and 6 months after enrollment. Average of 5.8 (SD=2.3) concussion related visits) 6-month treatment period	Health and Behavior Inventory (HBI), PHQ-9, PROMIS-PA8, Pediatric Quality of Life Inventory (PedsQL) Secondary: Client Satisfaction Questionnaire, chart review to identify demographic and health care utilization information.	57.5% had a sport-related concussion and 42.5% sustained a recreation related concussion. 98% follow-up was achieved at 1, 3, and 6 months. At 6 months, intervention patients had better improvements than controls in post-concussive symptoms (relative risk = 0.03) and health-related quality of life (child PedsQL mean difference of 9.8; 95% confidence interval 0.9 to 18.8; Parent PedsQL mean difference 14.0; 95% CI 4.6 to 23.1).	Bias: 19 Evidence: 2
Sohlbert et al, 2016, USA, Retrospective Case Series	n=24 individuals referred for cognitive rehabilitation for persistent (>2 months) sport-related concussion symptoms. Mean age 17.5 (SD = 3.2) years; 14 females and 10 males; median 5 months post injury Definition: Physician	1) Direct attention training (DAT) (n=13) 2) Metacognitive strategy instruction (MSI) (n=9) 3) Training assistive technology for cognition (ATC) for use in school (n=5) 4) Psychoeducation supports (including symptom monitoring and goal setting and/or concussion education)	Selected functional goals identified by clients (e.g. Improve attention during a lecture, increase homework completion, etc.)	DAT: 11/13 met self-selected goal, one no change and one discontinued treatment. MSI: 9/9 reported meeting their self-selected goals. ATC: 5/5 reported meeting their self-selected goals. Psychoeducational support: 22/24 met their self-selected	Bias: 12 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	diagnosis of concussion due to a sport-related injury	(n=24). Mean number of sessions = 8.3 (range 1-25) over mean duration of 9.6 (range 1-26) weeks. Duration 30-90 minutes.		functional goals.	
Grabowski et al, 2016, USA, Retrospective Case Series	n=25/33 patients with post-concussion syndrome (PCS) after a sport-related concussion who were referred for physical therapy Definition: PCS as defined by the World Health Organization (WHO)	Supervised Physical Therapy (PT): In-clinic visits at variable intervals based on individual needs and pertinent exam findings. Treatment included up to three of the following: 1) Sub-symptom cardiovascular exercise protocol, 2) Vestibular/oculomotor therapeutic exercise, 3) Cervicothoracic manual therapy and therapeutic exercise. A daily home program was also included. Sport specific training as preparing to return to play. Typical follow-up was at 1-2 week intervals. Median duration of 84 days (Range 7-266)	Post-Concussion Symptom Score (PCSS) (n-25) Balance Error Scoring System (BESS) (n=12) Graded Exercises Testing (GXT) (n=14)	88% (n=22) of patients reported an improvement in symptoms. PCSS total score decreased following treatment ($p<0.001$) 24%(n=6) were symptom free at the end of treatment. Symptom Free Heart Rate (SFHR) was higher at final appointment compared to baseline ($p<0.001$) BESS scores decreased from baseline to final assessment ($p<0.001$). Two individuals reported symptom exacerbation while performing cardiovascular exercise at home. 7/25 patients discontinued therapy.	Bias: 11 Evidence: 4
Schneider et. al; 2014, Canada Randomized Controlled Trial (RCT)	n=31; Age: 12-30 years (18 male, 13 female) with persistent (>10 days) dizziness, neck pain, and/or headaches following sport-related concussion Definition: As per 3rdInternational Consensus Conference on Concussion in Sport	Once weekly intervention or control treatment for 8 weeks or until time of medical clearance. Intervention: Individualized cervical spine and vestibular physiotherapy treatment + control intervention. Control: Non-provocative range of motion, stretching, and postural education as indicated and following the current standard of care (rest until symptom free followed by graded exertion)	Primary Outcome Measure: Number of days to medical clearance to return to sport defined by study sport medicine physician who was blinded to treatment group. Secondary Outcome Measures: 11-point Numeric Pain Rating Scale score, Activities-Specific Balance Confidence Scale, Dizziness Handicap Index, SCAT2, Dynamic Visual Acuity, Head Thrust Test, modified Motion Sensitivity Test, Functional Gait Assessment,	73% (11/15) of intervention group was medically cleared compared to 7% (1/14) of control group. Individuals in the treatment group were 3.91 (95% CI 1.34-11.34) times more likely to be medically cleared by 8 weeks (χ^2=9.31, p=0.002).	Bias: 25 Evidence: 2

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
			Cervical Flexor Endurance and Joint Position Error test.		
Hugentobler J.A.; 2015; USA Retrospective Case Series	n=6 (4 males, 2 females) aged 15-19 years, mean of 81.7 days from injury (SD=60.8) Definition: mTBI with protracted recovery as per the referring physician's personal designation	Intervention: Combination of in-clinic treatments including aerobic and anaerobic exercise, postural control (standing balance and dual tasking in standing balance positions), gaze stabilization, musculoskeletal treatments (stretching, resistance training, postural education, manual therapy) as per their individual examination. Progressed to sport specific activities. Duration: Average of 6.8 sessions over average of 8.9 weeks.	Return to pre-injury activity; Number of Symptoms and Symptom Severity [Post Concussion Symptom Scale (PCSS)], Sample Entropy (SampEn) and Balance Error Scoring System (BESS) for standing balance, Heart Rate, Blood Pressure	No statistical tests performed. One patient returned to full pre-injury activity; 4/6 returned to pre-injury level within 3-6 months of discharge.	Bias: 9 Evidence: 4
Treatment - Medical					
Bramley et al, 2015; USA Retrospective Case Series	Participants: n=400/520 consecutive patients (248 male, 152 female aged 13-18 years; 248 sport-related concussion) seen at a concussion clinic in Pennsylvania between 2006-2011 with complete resolution of symptoms (individuals without resolution of symptoms and those missing follow-up recommendations were excluded) Definition: Not provided	Intervention: Amitriptyline [Median dosage 25mg (Range 10-100mg)] and median duration was 4 months (IQR 2.0-7.0 months)	Not operationalized; Amitriptyline helped headache Yes/No	Sixty-eight (17%) were prescribed Amitriptyline and 82% (95% CI; 70-91%) reported that the medication helped. 23% (95% CI; 12-38%) reported side effects with over-sedation as the most common side effect. Females were more likely to be prescribed Amitriptyline (24% females versus 13% males).	Bias: 16 Evidence: 4
Reddy et al, 2013; USA Retrospective Quasi-experimental	Participants: n=25 adolescents (11 male, 14 female) with ongoing symptoms >21 days following a sport related concussion; mean age 15.54 ±1.42 years; historical	Intervention: Amantadine 100mg twice daily for 3-4 weeks Controls: Usual care with no medication	Immediate Postconcussion Assessment and Cognitive Test (ImPACT) computerized test battery and self-report symptom inventory (22-items).	Symptoms, verbal and visual memory, visual processing speed and reaction time improved in both groups over time. There were significant group differences at the start of the study with the	Bias: 21 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	controls from the same clinical population who did not receive medication treatment were matched based on age, sex, and previous history of concussion. Definition: Presentation of 1 or more of the following signs or symptoms after a direct or indirect impact to the head: (1) any noticeable change in mental status; (2) loss of consciousness, disorientation, posttraumatic amnesia, or retrograde amnesia; or (3) any self-reported symptoms (e.g., headache, dizziness, balance dysfunction, visual blurring, diplopia) that appeared following a direct or indirect impact to the head.			Amantadine group scoring worse than the control group for verbal and visual memory, and the amantadine group reporting more symptoms. The decrease in symptoms was greater in the Amantadine group than the controls (F=8.71, p=0.005). Performance improvements were greater in the Amantadine group than in the controls for verbal memory (F=8.71, p=0.005) and reaction time (F=7.35, p=0.009).	
Dubrovsky et al, 2014; USA Retrospective Case Series	n=28 consecutive patients presenting to mild traumatic brain injury clinic between Jan 2012 and June 2013 who received a greater occipital nerve (GON) block. Mean age 14.6 (SD±1.7) years, 80% female, 57% had a history of multiple concussions; 77% (21/30) of the cohort was sport-related concussion Definition: Working definition of concussion not provided. Patients met	Peripheral nerve blocks (greater occipital nerve block or in some cases lesser occipital nerve block or supraorbital nerve) with 2% Lidocaine with epinephrine using a 0.5" 30-gauge needle with 1cc volume (0.5cc for supraorbital nerve block).	Proportion of patients with a good therapeutic effect (defined as relief of symptoms for >24 hours following the block OR request for subsequent block as a proxy for patient perceived benefit)	62 injections were performed, 53% requested repeat nerve blocks, 93% reported good reduction in headaches, 7% reported partial reduction (<=24 hours) and 0% reported no effect. No one reported null effect of the blocks.	Bias: 12 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	International Headache Society International classification of headache Disorders (3rd edition) for "acute persistent headache attributed to mild TBI"				
Treatment - Other					
Pfaller et al, 2016; USA Prospective Cohort study	Participants: 143 contact and collision sport athletes who sustained a concussion (120 male, 23 female) mean age 17.6 ±2.0 years. Definition: US Department of Defense definition of concussion.	Exposure: Symptom free waiting period (SFWP) prior to returning to play OR No SFWP.	SCAT3 including subcomponents, ImPACT	99.3% of athletes used a SFWP. Mean symptom duration was 6.35 days and 99.3% recovered within 30 days. Repeat concussions occurred in 3.8% of participants.	Bias: 13 Evidence: 4
McCrea, et al; 2009; USA Prospective Cohort study	Participants: 635 high school and college athletes participating in one of three prospective cohort studies who were diagnosed with sport-related concussion [mean age 17.5 years (SD 1.6), 562 males, 73 females] Definition: Concussion was defined according to the AAN Guideline (i.e., "a trauma-induced alteration in mental status that may or may not involve loss of consciousness")	Exposure: Symptom free waiting period (SFWP) prior to returning to play OR No SFWP.	Graded symptom checklist (GSC), Balance Error Scoring System (BESS), Standardised Assessment of Concussion (SAC); Neuropsychological testing at 45 and 90 days following injury.	No significant differences between symptom or clinical recovery and symptom free waiting period. Most repeat concussions occurred within 10 days of initial injury. Individuals in SFWP group were withheld from competition longer than those in the no SFWP group (Mean difference 6.52 days; 95%CI, 4.74-8.30; p<0.001). 60.3% of participants completed a SFWP.	Bias: 23 Evidence: 3
Treatment - Exercise					
Cordingley et al, 2016, Canada, Retrospective Case Series	n=106 patients under the age of 19 years (mean 15.1 years, range 11-19 years) of which 58 were diagnosed with physiological post-concussion disorder (developed a symptom-limited threshold during testing)	Tailored submaximal exercise prescription: 5 days/week including 5 minute warm-up, 20 minutes aerobic exercise at 80% max heart rate achieved on treadmill test, 5 minute cool down. Follow-up every 2-4 weeks and treadmill testing repeated, return-to-play initiated or other	Clinically improved: Reported improvement in PCSS scores after initiation of exercise program; Not clinically improved: Did not report improvement in concussion symptoms and/or decreased PCSS scores; Incomplete	41/58 (70.7%) had complete follow-up. 24 prescribed submax aerobic exercise alone, 20 with concurrent vestibulo-ocular reflex retraining, 6 with concurrent cervical spine physiotherapy, 8 with concurrent vestibular rehabilitation and cervical	Bias: 6 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	Definition: According to the International Consensus Statement on Concussion in Sport	multidisciplinary intervention considered.	response: Initial clinical improvement but did not achieve full recovery; Full recovery: Asymptomatic at rest as per clinical interview and PCSS, asymptomatic with full school activities, normal neurological examination.	spine physiotherapy. Median duration of treatment was 50 days (IQR 32-123 days). 47/58 reported to improve, 4/58 not improved, 4/58 lost to follow-up, and 3/58 continuing treatment at end of study. 70.2% of those who reported improvement returned to play.	
Gagnon et al, 2009; Canada Case Series	Participants: n=16 children/adolescents aged 10–17 years (5 female) who sustained a concussion and experienced post-concussion symptoms for more than 4 weeks post-injury Definition: Physician diagnosed concussion	Intervention: Submaximal aerobic training (50-60% maximal capacity) on bike or treadmill (15 minutes); light sport specific coordination exercises (10 minutes); visualization and imagery techniques (5 minutes); education, home program (including sub-symptom sub-maximal aerobic training and coordination exercises)	Post-Concussion Scale-Revised score; return to normal physical activity participation	All subjects recovered within 2-12 weeks (mean 4.4 weeks). Mean Post-Concussion Scale-Revised score was 30.0(SD=20.8) at initial assessment and decreased to 6.7 (SD=5.7) at discharge from the programme. No stats reported. Patients reported high satisfaction with the programme.	Bias: 11 Evidence: 4
Gagnon et al, 2016, Canada Case Series	Participants: n=10 consecutive adolescents between 14-18 yrs of age (3 females) with symptoms > 4 weeks following a sport-related concussion who were referred to the Concussion Clinic of the Montreal Children's Hospital Trauma Centre. Definition: Physician diagnosed concussion	Intervention: Submaximal aerobic training (60% maximal capacity for up to 15 minutes); light coordination exercises (up to 10 minutes); visualization and positive imagery; individualized home program (daily for 20-30 minutes); intervention is followed by standard return to play protocol.	Primary outcome: Post-Concussion Scale; Secondary outcomes: Beck Depression Inventory–Second Edition and energy level (Pediatric Quality of Life Multidimensional Fatigue Scale); Balance and coordination (timed tasks on a foam surface); the Body Coordination composite of the Bruininks-Oseretsky Test of Motor Proficiency; and cognitive function (ImPACT) Assessed weekly at clinic visits or follow-up phone call until child asymptomatic at rest for one	Decrease in their symptoms between initiation of the intervention and the 6-week follow-up assessment (t=3.79; p=0.004; d=1.83). Treatment lasted 2-15 weeks (mean 6.8 weeks).	Bias: 15 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
			week and then enters the return to play protocol.		
Leddy et al, 2010; USA Prospective case series	Participants: n=12 consecutive patients (6 athletes; 6 non-athletes), mean age of 27.9 years (16-53 years), 5 females. Definition: Post-concussion syndrome (PCS) as per the World Health Organization definition [symptoms following a concussion at rest for > 6 weeks but < 52 weeks (by study physician interview)] and demonstrate symptom exacerbation during a graded treadmill exercise test.	Intervention: Daily progressive subsymptom threshold aerobic exercise training program (5-6 times per week) for the duration reached on the most recent treadmill test, at 80% of symptom exacerbation threshold (ST) maximum heart rate. Continued until physiologic resolution of post-concussion syndrome (PCS).	Adverse reactions to exercise, Graded Symptoms Checklist (GSC) symptom reports; Heart Rate (HR), systolic blood pressure (SBP), Oxygen consumption (estimated using treadmill speed and grade); achievement of peak exertion without symptoms, return to work/sport. Tests performed at baseline, after 2-3 weeks of rest, and every 3 weeks until no exertional symptoms were present.	No adverse events reported. Improvement scores from baseline to conclusion of treatment for maximal exercise HR, SBP, and exercise time were highly correlated with each other (r= 0.56–0.84, p=03). Correlation between improved exercise capacity (maximal treadmill HR) with improvement in symptoms over time. A paired t-test demonstrated an overall symptom reduction (no test statistic presented, p=.002). Exercise time improved (repeated measures analysis of variance, p=.001). All recovered and reached physiologic criteria for treatment success.	Bias: 16 Evidence: 4
Leddy et al, 2013, USA Quasi-experimental	Participants: n=10 (consecutive patients presenting to University Concussion Clinic; 5 females, age range 17-52 years), n=5 (healthy controls recruited from the community; 4 females, age range 18-34 years) Controls matched on age, sex and athletic status. *2 PCS patients dropped from analysis due to concomitant/other diagnoses on fMRI and one healthy control dropped	First 5 participants assigned to exercise, following 5 to stretching. Exercise group: Individualized subthreshold aerobic exercise at 80% of heart rate (HR) attained on the treadmill test, 20 minutes per day using HR monitor, 6 days per week. Stretching group: Gradually progressive 12 week low impact breathing and stretching program via a booklet with text and figures; asked not to exceed 40-50% of max HR and wore HR monitor 20 minutes per day, 6 days per week.	Primary: Cerebral blood flow changes measured by fMRI activation patterns; Secondary: HR achieved during exercise treadmill test, Number of symptoms on Post-Concussion Scale.	Time 1: No difference in fMRI activation between the 2 PCS groups but healthy controls had significantly greater activation in the posterior cingulate gyrus, lingual gyrus, and cerebellum versus all PCS subjects (p<.05, corrected for multiple comparisons). Time 2: Exercise PCS not different from healthy controls; placebo stretching PCS had significantly less activity in cerebellum (p<.05 corrected) and in the anterior cingulate gyrus and thalamus (p<.001,	Bias: 15 Evidence: 4

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
	out after first fMRI due to scheduling conflict thus 8 in PCS group and 4 healthy controls. Definition: Post-concussion syndrome, exacerbation of symptoms with progressive exercise test and symptomatic for more than 6 weeks and less than 12 months following injury; Post-Concussion Syndrome as per the WHO ICD-10 definition			uncorrected) versus healthy controls; exercise PCS achieved a significantly greater exercise HR (paired t-test, p<.001) and had fewer symptoms (paired t-test, p<.0004) than placebo stretching PCS. Cognitive performance did not differ by group or time.	
Majerske et al, 2008; USA Retrospective Cohort Study	Participants: n=95 student-athletes (80 males aged 15.9 +/-1.4 years, 15 females aged 16.3 +/- 1.3 years) Definition: not given	Exposure: Retrospective assignment to group on Activity intensity scale (AIS): 0=no school or exercise activity; 1=school activity only; 2=school activity and light activity at home (e.g., slow jogging, mowing lawn); 3=school activity and sports practice; 4=school activity and participation in sports game	Post-Concussion Symptom Scale (PCSS) scores and ImPACT neurocognitive test scores (verbal memory, visual memory, visual motor)	Adjusted symptom scores decreased over time (p<0.001) as did neurocognitive scores (p<0.002). Athletes in the highest activity levels had the worst visual memory scores and individuals in AIS 3 and 4 had worse visual memory than AIS 2 (p<0.05).	Bias: 14 Evidence: 4
Maerlender et al, 2015; USA Pilot Randomized Controlled Trial (RCT)	Participants: n=28 college athletes with acute concussions (20 Female and 8 male) Definition: No definition of concussion other than enrolled right after assessed by ATC.	Intervention: Exertion (n=13): Schwinn Airdyne stationary bicycle at a perceived exertion level of "mild to moderate" (0 to 6 on the RPE scale: as per Borg,1998) 20 minutes daily until clinical recovery. Discontinued if symptom increases were uncomfortable for the athlete. Control (n=15): Asked to engage in no systematic exertion other than normal activities for school.	Days to recovery, ImPACT neurocognitive test battery, Borg CR10 Rate of Perceived Exertion (RPE) scale, Post-ride symptom change rating, Likert scale to rate change in symptoms following exertion, Actical actigraphs to measure physical activity.	No significant difference between group in median time to recovery (Fisher's exact test, p=0.71). 10% of rides were not completed due to feeling badly. More bike rides resulted in symptom change (x^2=4.76, p=0.03) with a 7 symptom increase per "strenuous" ride. First day symptom increase was not related to recovery time (R^2=.12, p=0.25). Average amount of vigorous physical exertion related to increased recovery time; r^2=.18,	Bias: 18 Evidence: 2

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Authors, year, country, Study design	Participants (n, age, sex); Definition of concussion	Intervention (frequency, duration, operational definition of intervention)	Outcome	Results (including statistical outcomes)	Risk of Bias score (Downs and Black); Level of evidence
				p=0.039)	
Kurowski et al, 2016; USA Pilot Randomized Controlled Trial (RCT)	Participants: 30 adolescents between 12-17 years (Mean age 14.3 years) Definition: Mild Traumatic Brain Injury (mTBI) defined as per American Congress of Rehabilitation definition. Persistent symptoms defined as per WHO ICD 10 criteria for post-concussion syndrome.	Intervention: Individual subsymptom exacerbation aerobic training 5-6 days per week at 80% of duration that exacerbated symptoms during assessment visit; Control: Full-body stretching 5-6 days per week at home; stretches included trunk, upper body, and lower body stretching. Intervention continued for 6 weeks or until able to perform exercise program with no exacerbation of symptoms.	Post-Concussion Symptom Inventory (PCSI) Parent-reported PCSI and adherence also reported.	Greater rate of improvement in the subsymptom exacerbation aerobic training group than in the full-body stretching group (F = 4.11, p = .044). Adherence to home exercise program was lower in the subsymptom exacerbation aerobic training group than the full-body stretching group [mean (SD) times per week = 4.4 (2.0) vs 5.9 (1.8), p < .0001] over the duration of the study	Bias: 25 Evidence: 2
Clausen et al, 2016, USA. Prospective Case series	Nine female Division 1 collegiate team athletes with PCS (23 ± 6 years) and a reference group of 13 healthy female recreational aerobic athletes (21 ± 3 years). Six PCS athletes were subsequently measured before and after treatment. Definition: PCS was defined per the World Health Organization definition [symptoms following a concussion at rest for > 6 weeks but < 52 weeks (by study physician interview)] and demonstrated early symptom exacerbation.	Intervention: individualized sub-threshold aerobic exercise at 80% of heart rate (HR) attained on initial treadmill test, 20 minutes per day using HR monitor, 6 days per week. Exercise intensity increased progressively over 12 weeks until normal exercise tolerance achieved without symptoms.	Recovery was defined as self-reported baseline symptoms (Post concussion symptom scale (PCSS) and ability to exercise to voluntary exhaustion without exacerbation of concussion symptoms on the BCTT. Secondary outcomes included recovery of cerebral blood flow velocity (CBFV) measured by Transcranial Doppler, CO_2 sensitivity, exercise ventilation, and end tidal CO_2 levels.	After sub-threshold exercise treatment, all 6 subjects became asymptomatic and restored normal exercise tolerance (85% of their age predicted maximum HR). Exercise VE increased significantly and PETCO2 and CBVF decreased significantly following treatment and was not different than the reference group.	Bias: 14 Evidence: 4

Note: The Downs and Black Risk of Bias scores are reported.

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