

Supplementary Table 3: Characteristics of included studies

Ref.	Study design	Sport and duration of career	Sportspeople population and recruitment	Comparison group	Variables adjusted for in the analysis	Funding	NOS score
Rugby							
McMillan TM et al, 2017 (32)	Cross-sectional with external comparison group ("population" controls)	Retired international rugby players (Scottish Rugby Union) Average number of international matches played: 24 (SD 24; IQR 5-40)	– 52 retired rugby international players – Mean age (SD): 53.5 (13.0) – Recruited through Scottish Rugby Union – Response rate: 52/~350 former players, 71 of whom volunteered and were eligible (15%)	– 46 population controls – Mean age (SD): 55.1 (9.0) – Recruited as friends and family members of the rugby players, members of community groups, or teachers	Age, Scottish Index of Multiple Deprivation, education	Sackler Foundation, Chief Scientist Office, NHS Research Scotland Career Researcher Fellowship	4
Hume et al, 2017 (31)	Cross-sectional with between sports (community rugby players and non-contract sportspeople) and external comparison group (US norms)	Elite New Zealand rugby players Mean career duration in years 23.0 (SD 8.1)	– 103 former elite rugby players (national or international) – Age range: 29-72, mean age 41.3 (SD 7.5) – Self-selected cohort from the larger Rugby Health project (N=485) – Response rate (including elite rugby N=103, community rugby N=198, non-contact sport retiree N=65): 75% but impossible inferring on the original response rate	BETWEEN SPORTS COMPARISON – 198 community rugby players – Age range: 29-72, mean age 44.9 (SD 8.4) – 65 non-contact-sport retirees (cricket and field hockey players) – Age range: 29-72, mean age 42.1 (SD 7.7) – Both groups self-selected cohort from the larger Rugby Health project EXTERNAL COMPARISON – US norms	None ("No significant correlations were observed between former players' demographic characteristics (e.g. age, education level, ethnicity, alcohol use) or sport played/level with the neuropsychological variables, therefore these factors were not used as covariates in analyses")	Not disclosed	2
Decq et al. 2016 (27)	Cross-sectional with a between sports comparison group (high level retired sportspeople)	Retired rugby players who have reached the first division championship level in France between 1985 and 1990 Minimum 10 years	– 239 retired rugby players – Age range: 49-55 years – Identified from French first division championship game sheets – 1,491 players identified, 1,047 contacted, 524 invited to participate, and 239 included. Response rate: 46% or 23% depending on selection criteria used	– 138 control from high levels sports with 'low risk' of recurrent concussion – Age range: 49-55 years – Identified through sporting federations – Out of 637 sportsmen, 455 were invited to participate and 138 were included. Response rate 30%, or 22% depending on selection criteria used	Not clear which variables collected were adjusted for in the analysis (smoking and education?)	Fédération Française de Rugby and the Ligue Nationale de Rugby	3
Ice Hockey							
Esopenko C et al, 2018 (28)	Cross-sectional study with external comparison group ("community" controls)	National Hockey League and other professional and minor professional leagues No information given on length of career	– 33 former professional hockey players – Mean age (SD): 54.3 (10.4) – Recruited through NHL Alumni Association by email, media presentations, participation in local hockey tournaments and word of mouth – Response rate not given	– 18 age-matched comparison group of healthy males recruited from the community with no history of concussion – Mean age (SD): 53.5 (10.2) – Recruited from the "community" – Response rate not given	N/A (Principle component analysis used)	Canadian Institute of Health Research Catalyst, Ontario Neurotrauma Foundation	4

American Football (US and Canadian)							
Baker JG, et al 2018 (24)	Cross-sectional study with between sports comparison group (non-contact master athletes)	National Football League (NFL) and National Hockey League (NHL) players Minimum 2 season play (85)	<ul style="list-style-type: none"> – 21 retired players – Age: 36 to 72 years – Mean age: 56.7 years – Recruitment through the alumni association with not clear procedures but based on volunteering (the authors reported that alumni too sick to participate and those with a public role were underrepresented) (85) 	<ul style="list-style-type: none"> – 21 non-contact sport master athletes – Age: 36- 72 years – Mean age: 55.4 years – No history of concussion – Recruitment and response rate not clear 	Age education and ethnicity normative scores used	Not stated	1
Misquitta K et al, 2018 (33)	Cross-sectional study with two external comparison groups (“population” controls and controls from the Cambridge Centre for Aging and Neuroscience)	Former Canadian football players Played at least a season with Canadian Football League Median (IQR) years in CFL: 9 (5-11)	<ul style="list-style-type: none"> – 53 former Canadian football players – Mean age: 55 ± 13 years – Recruitment unclear – Response rate not reported 	<p>FIRST COMPARISON GROUP</p> <ul style="list-style-type: none"> – 25 age- and education-matched controls – Mean age: 51 ± 10 years – Recruited from the general population <p>SECOND COMPARISON GROUP</p> <ul style="list-style-type: none"> – 321 age-matched male controls from the Cambridge Centre for Aging and Neuroscience (CAMCAN) – Mean age: 58 ± 16 years 	None	Physicians' Services Incorporated Foundation and the Toronto General and Western Hospital Foundation	4
Alosco et al, 2017 (22)	Cross-sectional study with external comparison group	NFL players Minimum 2 years of active playing time in the NFL 12 or more total years of participation in tackle football	<ul style="list-style-type: none"> – 124 retired NFL players – Age range: 40-69 years – Median years in CFL (IQR): 9 (5-11) – With self-reported complains of cognitive, behavioural and mood symptoms for at least 6 months – Sample of participants recruited in DETECT through e-mails, NFL Alumni Association, Boston University Alzheimer's Disease and CTE Center social media – Response rate not reported 	<ul style="list-style-type: none"> – 28 age-matched controls – Aged 40-69 – No history of participating in contact sport nor of concussion – Recruited through social media and word of mouth 	Age and education	National Institute of Health (NIH)	6
Multani et al. 2016 (34)	Cross-sectional with external comparison group	Canadian Football players with history of multiple concussions Duration of career 7.8±4 years	<ul style="list-style-type: none"> – 18 retired Canadian Football players selected on the basis of history of multiple concussion – Mean age: 49.6±12 years – Playing history: 7.8±4 years – Recruitment unknown 	<ul style="list-style-type: none"> – 17 age- and education- matched controls, no reported concussion history – Mean age: 46.7±10 years – Recruitment not stated 	None	PSI Foundation and the Canadian Sports Concussion Project, Krembil Neuroscience Centre, Toronto Western Hospital	2
Hart et al. 2013 (30)	Cross-sectional with external comparison group	American Football players 2-15 years	<ul style="list-style-type: none"> – 34 retired NFL players – Age range: 41-79 years – Mean age 61.8 years (95% CI, 57.8-65.7) – Recruited from meeting of the NFL Players Association local chapter (North Texas), word of mouth and advertising. Sample made of volunteers who asked to participate 	<ul style="list-style-type: none"> – 26 healthy controls with no history of concussion – Age range: 41-79 – Mean age: 60.1 (95% C.I. 54.6-64.1) – Recruited from normal aging studies at the Centre for Brain Health at the University of Texas at Dallas – 26 out of the original (31%) 85 screened included 		Brain-Health Institute for Athletes at the Center for Brain-Health (University of Texas Dallas) and National Institute on Aging	4

Randolph et al., 2013 (35)	Cross-sectional with two external comparison groups (one of patients diagnosed with MCI) and population norms	American Football NFL players Length of career not stated Among those cognitively impaired, mean (SD) career: 7.5 (3.4) years	<ul style="list-style-type: none"> – 513 retired NFL players – Mean age 64.2 years (SD 5.5) – Initial sample of NFL players affiliated with the NFL Player's Association invited (N=3729) with 68% response rate – New data collection on 908 of them aged 50+ (response rate 57%) 	<ul style="list-style-type: none"> – 81 patients diagnosed with MCI by a neuropsychologist according to the core clinical criteria of the revised NIA-AA guidelines (88) – 41 cognitively normal subjects was extracted from the RBANS standardization database to match the NFL sample on the basis of age, education, and gender 	None (the healthy control sample was matched on demographic variables)	Martek Biosciences Corporation	3
Amen et al. 2011 (23)	Cross-sectional with external comparison group	American Football In active NFL roster for a minimum of 3 years	<ul style="list-style-type: none"> – 100 Active and retired NFL players – Age range: 25-82 years – Mean age: 52.3 (SD 12.4) – Recruited from retired NFL Players Association meetings and word of mouth. 	<ul style="list-style-type: none"> – 20 healthy controls, no documented concussion history for SPECT – Standardized sample (N=810), chosen to be representative to the U.S. population of adults between the ages of 18 and 89 with regard to education, gender, and ethnicity for the MicroCog test 	None	Not disclosed	3
Guskiewicz et al. 2005 (29)	Cross-sectional with external comparison group	American football players Mean duration of overall career of 15.1 years (SD 4.3) Mean duration of professional career 6.6 years (SD 3.6)	<ul style="list-style-type: none"> – 758 retired footballers aged 50+ years – Mean age: 53.8 years (SD 13.4) – Members of National Football League Retired Player's Association, US – Minimum 2 seasons as professional footballers – Recruitment procedures not clear, response rate not given 	<ul style="list-style-type: none"> – External comparison: age-adjusted prevalence ratios using estimates from the general population – Internal comparison: concussed vs. not concussed 	Not clear which variables collected were adjusted for in the analysis	Not disclosed	5
Boxing and Martial Arts							
Bang et al. 2016 (25)	Case-series with external comparison group	Boxing At least 10 years	<ul style="list-style-type: none"> – 5 professional retired boxers – Age range: 42-49 years – Career duration of 8-19 years – Recruitment criteria not stated 	<ul style="list-style-type: none"> – 4 age matched controls with no history of concussion – Age range: 46-53 years – Recruitment criteria not stated 	None	Ministry of Health & Welfare, Republic of Korea and Ministry of Science, ICT and Future Planning, Republic of Korea	1
Bernick et al. 2015 (26)	Cross-sectional study (baseline of a cohort study), with external comparison group	Fighters (both martial arts fighters and boxers) Licensed to fight professionally in one of the combat sports	<ul style="list-style-type: none"> – 224 fighters (93 boxers, 131 MMA) – Age range: 18-44 years – Career duration: 0 – 24 years (mean: 4 years) – Professional fights range: 0-101 (mean:10) – Recruited from the Professional Fighters Brain Health Study 	<ul style="list-style-type: none"> – 22 age and education matched controls – No history concussion, or participation in high risk sport 	Results adjusted for intracranial volume, age, race and education	Not disclosed	6