Table 1

*Injury Characteristics of the 92 Sports-Related Concussion Samples Comprising the Meta-Analytic Database from which Samples were drawn for the Current Analyses, arranged by comparison group.*

| Sample [sub-sample] a | Concussed; Controls |  | Classification criteria |  | Grade of severity (% of sample) |  | Post-concussion signs and symptoms (% of sample) |  | History of previous concussion (% of sample) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample size | Age (in years) |  | Diagnostic criteria or severity grading scale | LOC |  | 1 | 2 | 3 |  | LOC | RA | AA | H | D | Do |  | *M* (SD) | None | 1≤ | 2≤ | 3≤ |
| **Pre-injury baseline and independent control group comparison** |
| Barr & McCrea ([2001](#_ENREF_3)) | 50; 68 | 17.2; 18.1 |  | AAN; ACRM | <30min |  | N | N | N |  | - | - | - | - | - | - |  | - | - | - | - | - |
| Cavanaugh et al. ([2005](#_ENREF_13)) | 27; 30  | 19.5; 21.7  |  | CS | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 56 | 22 | 4 | - |
| Collie et al. ([2006](#_ENREF_19)) | 61; 84 | 22.9; 23.4  |  | CISG (2002) | Any alt. |  | N | N | N |  | 25 | - | 36 | 89 | - | - |  | 2.7 (2.4) | - | - | - | - |
| Echemendia et al. ([2001](#_ENREF_29)) | 29; 20  | *-*; *-*  |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Field et al. ([2003](#_ENREF_35)) [high school] | 19; 20  | 15.2; 16.6  |  | CS; AAN | Any alt. |  | - | - | 11 |  | 11 | - | - | - | - | - |  | 0.6 (0.7) | 47 | 53 | 8 | - |
| Field et al. ([2003](#_ENREF_35)) [college] | 35; 18  | 19.9; 20.1  |  | CS; AAN | Any alt. |  | *-* | *-* | 34 |  | 34 | *-* | - | - | - | - |  | 1.5 (1.3) | 47 | 53 | 36 | - |
| Guskiewicz et al. ([1996](#_ENREF_38)) | 10; 10  | 17.4; 18.6  |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Guskiewicz et al. ([2001](#_ENREF_40)) | 36; 36 | 19.5; 20.0  |  | CS | Any alt. |  | N | N | N |  | 19 | 19 | 31 | 92 | 72 | 58 |  | - | - | - | - | - |
| Hinton-Bayre et al. ([1997](#_ENREF_42)) | 10; 10  | 22.1; 19.9  |  | CNS; NHMRC | Any alt. |  | N | N | N |  | 0 | *-* | - | - | - | - |  | 2.6 (1.8) | - | - | - | - |
| Hinton-Bayre et al. ([1999](#_ENREF_41)) | 20; 13  | 21.1; 19.6  |  | CNS; AAN | Any alt. |  | 10 | 70 | 20 |  | 20 | *-* | - | - | - | - |  | 2.4 (2.4) | 15 | 85 | - | - |
| Iverson et al. ([2003](#_ENREF_45)) | 41; 56 | 16.8; 17.6  |  | AAN | *-* |  | 54 | 22 | 7 |  | 7 | *-* | - | - | - | - |  | - | - | - | - | - |
| Johnson et al. ([2002](#_ENREF_47)) | 9; 9  | *-*; *-*  |  | CoMS  | Any alt. |  | *-* | *-* | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Lovell & Collins ([1998](#_ENREF_50)) | 4; 40  | *-*; 19.6 |  | CS; AAN | Any alt. |  | 100 | 0 | 0 |  | 0 | *-* | - | 100 | - | - |  | 1.0 | - | 100 | - | - |
| Lovell et al. ([2003](#_ENREF_51)) | 64; 24 | *-*; *-*  |  | CS  | Exc |  | N | N | N |  | 0 | 20 | 30 | - | - | 44 |  | - | - | - | - | - |
| Macciocchi et al. ([1996](#_ENREF_55)) | 183; 48  | 19.0; 19.0 |  | CS | <2min |  | N | N | N |  | 5 | - | 34 | 71 | 35 | 95 |  | - | 58 | 20 | 11 | 12 |
| Maddocks & Saling ([1996](#_ENREF_58)) | 10; 10 | *-*; *-*  |  | CNS | *-* |  | N | N | N |  | 50 | - | 100 | - | - | - |  | - | 60 | 40 | 0 | 0 |
| Makdissi ([2001](#_ENREF_59)) | 6; 7  | 20.5; 20.3  |  | CNS | Any alt. |  | N | N | N |  | 17 | *-* | - | 83 | 67 | - |  | - | - | - | - | - |
| McCrea ([2001](#_ENREF_61)) | 63; 55  | 18.2; 18.2  |  | AAN | Any alt. |  | N | N | N |  | 5 | - | 6 | - | - | - |  | - | - | - | - | - |
| McCrea et al. ([2003](#_ENREF_62)) | 94; 56 | 20.0; 19.2  |  | CS; [Cantu (2001](#_ENREF_11)) | Any alt. |  | 15 | 70 | 15 |  | 6 | 7 | 19 | 85 | - | - |  | 0.6 (0.8) | 62 | 21 | 8 | 5 |
| Peterson et al. ([2003](#_ENREF_76)) | 24; 18 | 20.2; 19.3  |  | CS; AAN | Any alt. |  | 13 | 83 | 4 |  | 4 | *-* | - | 74 | - | - |  | 5 | 79 | 21 | - | - |
| Piland et al. ([2003](#_ENREF_77)) | 17; 16 | 19.8; 19.5  |  | AAN | Any alt. |  | 6 | 94 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Sim et al. ([2008](#_ENREF_82)) | 14; 14 | 15.5; 15.7 |  | ACRM | Any alt. |  | N | N | N |  | 14 | - | 29 | - | - | - |  | - | 57 | 43 | - | - |
| Sosnoff et al. ([2007](#_ENREF_88)) | 22; 22 | 19.8; *-*  |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 41 | 59 | - | - |
| **Independent control group comparison only** |
| Bruce & Echemendia ([2003](#_ENREF_8)) | 19; 19  | 20.1; 19.9  |  | AAN | Any alt. |  | N | N | N |  | 21 | 26 | 68 | - | - | - |  | - | 47 | 37 | 16 | 0 |
| Bruce & Echemendia ([2004](#_ENREF_9)) [>1 previous concussions] | 30; 147  | 20.2; 19.0  |  | AAN | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 0 | 57 | 43 | - |
| Bruce & Echemendia ([2004](#_ENREF_9)) [0 previous concussions] | 27; 286 | 20.2; 18.8  |  | AAN | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Chen et al. ([2007](#_ENREF_15)) | 18; 10 | 28.9; 21.9  |  | CISG (2005); AAN | >1min |  | *-* | *-* | 11 |  | 11 | - | 22 | 45 | 11 | - |  | 3.7 (1.4) | - | - | - | - |
| Chen et al. ([2008a](#_ENREF_16)) | 16; 16 | 26.0; 20.0  |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | 3.4 (1.8) | - | - | - | - |
| Chen et al. ([2008b](#_ENREF_17)) | 9; 6 | 31.5; 20.0  |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | 4.2 (1.4) | - | - | - | - |
| Cremona-Meteyard & Geffen ([1994](#_ENREF_26)) [Experiment 1] | 9; 12 | 23.0; 22.1  |  | CS | >2min, <20min |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 33 | 11 | 33 | 22 |
| Dupuis et al. ([2000](#_ENREF_28)) | 20; 10 | 21.5; 21.5  |  | AAN | Any alt. |  | *-* | *M,* 2.0 | *-* |  | *-* | *-* | - | - | - | - |  | 2.9 | 0 | - | - | - |
| Ellemberg et al. ([2007](#_ENREF_30)) | 10; 12 | 22.7; 22.3  |  | AAN | Any alt. |  | 0 | 100 | 0 |  | 0 | *-* | - | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Fazio et al. ([2007](#_ENREF_33)) | 122; 70 | 16.7; 17.3  |  | CS | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 76 | 14 | 7 | 3 |
| Ferguson et al. ([1999](#_ENREF_34)) | 50; 159 | 20.2; 19.6  |  | CS | Any alt. |  | N | N | N |  | *-* | *-* | 56 | 18 | 18 | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Gosselin et al. ([2006](#_ENREF_37)) | 20; 10 | 25.9; 22.0  |  | AAN | Any alt. |  | *-* | *M,* 2.4 | *-* |  | *-* | *-* | - | - | - | - |  | 4.3 (3.6) | - | - | - | - |
| Gosselin et al. ([2009](#_ENREF_36)) | 10; 11 | 24.3; 22.6  |  | WHO | <30min |  | N | N | N |  | 20 | - | 40 | - | - | - |  | 4.6 (2.1) | 0 | 0 | 10 | 90 |
| Guskiewicz et al. ([1997](#_ENREF_39)) | 11; 11 | 18.6; 20.2 |  | CNS; CS | <20min |  | N | N | N |  | 55 | 36 | 18 | 91 | 82 | 64 |  | - | - | - | - | - |
| Killam et al. ([2005](#_ENREF_48)) | 5; 9 | 22.6; 22.0  |  | AAN | Any alt. |  | *-* | *-* | *-* |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Lovell et al. ([2006](#_ENREF_53)) [high school] | 221; 707 | 16.5; *-*  |  | CISG (2002) | Any alt. |  | N | N | N |  | *-* | *-* | - | 92 | 61 | - |  | - | - | - | - | - |
| Lovell et al. ([2006](#_ENREF_53)) [college] | 39; 1039  | *-*; *-*  |  | CISG (2002) | Any alt. |  | N | N | N |  | *-* | *-* | - | 92 | 61 | - |  | - | - | - | - | - |
| Lovell et al. ([2006](#_ENREF_53)) [repeat assessment] | 52; 1746  | *-*; *-*  |  | CISG (2002) | Any alt. |  | N | N | N |  | *-* | *-* | - | 92 | 61 | - |  | - | - | - | - | - |
| Maddocks et al. ([1995](#_ENREF_57)) | 28; 28 | *-*; *-*  |  | CS | Any alt. |  | N | N | N |  | 39 | *-* | - | 93 | 64 | - |  | - | - | - | - | - |
| McCrea et al. ([2002](#_ENREF_63)) | 91; 45 | 17.3; 17.5  |  | AAN; ACRM | <30min |  | 84% no LOC/no AA9% AA/no LOC8% LOC & AA |  | 8 | - | 17 |  |  | - | - | - | - | - | - | - |
| Moser & Schatz ([2002](#_ENREF_68)) | 14; 21  | 16.4; 16.8  |  | AAN | Any alt. |  | 0 | *-* | *-* |  | *-* | *-* | - | - | - | - |  | - | 3 | 34 | 49 | 14 |
| Moser et al. ([2005](#_ENREF_69)) | 40; 183 | 15.8; 15.7  |  | AAN | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 20 | 23 | 28 | - |
| Parker et al. ([2005](#_ENREF_71)) | 10; 10 | 20.2; 19.9  |  | AAN | Exc |  | 0 | 100 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Parker et al. ([2006](#_ENREF_72)) | 15; 15 | 20.6; 20.6  |  | AAN | Any alt. |  | 0 | 100 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Parker et al. ([2008](#_ENREF_73)) | 14; 14 | 20.7; 20.6  |  | AAN | Exc |  | 0 | 100 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Pellman et al. ([2006](#_ENREF_74)) [high school] | 37; 125  | 15.8; 15.6  |  | CS | Any alt. |  | N | N | N |  | 35 | 51 | 51 | - | - | 70 |  | 0.9 | - | - | - | - |
| Pellman et al. ([2006](#_ENREF_74)) [professional] | 48; 68  | 26.3; 24.3  |  | CS | Any alt. |  | N | N | N |  | 23 | 23 | 20 | - | - | 71 |  | 1.2 | - | - | - | - |
| Riemann & Guskiewicz ([2000](#_ENREF_80)) | 16; 16 | 19.2; 22.5  |  | CS; [Cantu (1998](#_ENREF_10)) | <20min |  | *-* | *-* | 0 |  | 13 | 13 | 25 | 94 | 44 | 38 |  | - | - | - | - | - |
| Schatz et al. ([2006](#_ENREF_81)) | 72; 66 | 16.5; 17.3  |  | CS | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 0 | 83 | 17 | - |
| Thompson et al. ([2005](#_ENREF_89)) | 12; 12 | 21.0; 21.0  |  | CS | Any alt. |  | *-* | *-* | 0 |  | *-* | *-* | - | - | - | - |  | 1.0 (0) | 0 | 100 | 0 | 0 |
| **Pre-injury baseline comparison only** |
| Broglio et al. ([2007a](#_ENREF_5)) [simple concussion b] | 17  | 19.8 |  | CISG (2005) | Exc |  | 0 | 100 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Broglio et al. ([2007a](#_ENREF_5)) [complex concussion b] | 4  | 19.8 |  | CISG (2005): | >1 min |  | 0 | 0 | 100 |  | 100 | *-* | - | - | - | - |  | - | - | - | - | - |
| Broglio et al. ([2007b](#_ENREF_6)) | 75 | *-* |  | AAN | Any alt. |  | 25 | 68 | 7 |  | 7 | *-* | - | - | - | - |  | - | - | - | - | - |
| Broshek et al. ([2005](#_ENREF_7)) [female] | 37  | 17.5 |  | Sideline assessment; AAN [Cantu(2001)] | Any alt. |  | 8 [41] | 82 [27] | 11 [33] |  | 11 | *-* | - | - | - | - |  | - | 54 | 26 | 11 | 9 |
| Broshek et al. ([2005](#_ENREF_7)) [male] | 94  | 19.2 |  | Sideline assessment; AAN [Cantu(2001)] | Any alt. |  | 11 [48] | 71 [23] | 18 [29] |  | 18 | *-* | - | - | - | - |  | - | 54 | 26 | 11 | 9 |
| Cavanaugh et al. ([2006](#_ENREF_14)) [steady c] | 16  | *-* |  | MO; Postural instability at 48hrs | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Cavanaugh et al. ([2006](#_ENREF_14)) [unsteady c] | 13  | *-* |  | MO; Postural instability at 48hrs | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Collins et al. ([2003](#_ENREF_20)) [goodd] | 44  | 15.5 |  | CS; AAN | Any alt. |  | 56 | 44 | 19 |  | 12 | 5 | 13 | - | - | 72 |  | - | 31 | 60 | 20 | - |
| Collins et al. ([2003](#_ENREF_20)) [poord] | 34  | 17.4 |  | CS; AAN | Any alt. |  | 56 | 44 | 19 |  | 21 | 34 | 38 | - | - | 71 |  | - | 31 | 70 | 20 | - |
| Collins et al. ([2006](#_ENREF_21)) | 136 | 16.1 |  | CS | Any alt. |  | N | N | N |  | 15 | 27 | 25 | 93 | 77 | 68 |  | - | 72 | 28 | - | - |
| Covassin et al. ([2007](#_ENREF_24)) [female] | 39  | *-* |  | AAN | Any alt. |  | 66 | 34 | 0 |  | 13 e | - | 15 | - | - | - |  | - | 48 | 20 | 32 | - |
| Covassin et al. ([2007](#_ENREF_24)) [male] | 41  | *-* |  | AAN | Any alt. |  | 59 | 34 | 7 |  | 24 | - | 20 | - | - | - |  | - | 48 | 20 | 32 | - |
| Covassin et al. ([2008](#_ENREF_25)) [≥2 previous concussions] | 21  | 21.1 |  | AAN | Any alt. |  | 71 | 5 | 24 |  | 24 | - | 29 | - | - | - |  | - | 0 | 0 | 100 | - |
| Covassin et al. ([2008](#_ENREF_25))[0 previous concussions] | 36  | 20.6 |  | AAN | Any alt. |  | 81 | 11 | 8 |  | 8 | - | 11 | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Daniel et al. ([2002](#_ENREF_27)) | 21 | *-* |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Erlanger et al. ([2001](#_ENREF_32)) | 26 | 18.6 |  | Cantu (2001) | Any alt. |  | 46 | 23 | 31 |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Erlanger et al. ([2003](#_ENREF_31)) | 47 | 17.6 |  | MO | *-* |  | N | N | N |  | 26 | 13 | - | 94 | 85 | 83 |  | - | 32 | 26 | 19 | 24 |
| Iverson et al. ([2004](#_ENREF_44)) [≥3 previous concussions] | 19  | 17.8 |  | CS | Any alt. |  | N | N | N |  | 11 | 16 | 37 | - | - | 63 |  | - | 0 | 0 | 0 | 100 |
| Iverson et al. ([2004](#_ENREF_44))[0 previous concussions] | 19  | 17.9 |  | CS | Any alt. |  | N | N | N |  | 0 | 16 | 5 | - | - | 26 |  | 0 (0) | 100 | 0 | 0 | 0 |
| Iverson et al. ([2006](#_ENREF_43)) | 30 | 16.1 |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 73 | 13 | 7 | 7 |
| Jantzen et al. ([2004](#_ENREF_46)) | 4 | 20.0 |  | AAN | Any alt. |  | 25 | 75 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| Lavoie et al. ([2004](#_ENREF_49)) | 10  | 21.5 |  | AAN | Any alt. |  | 10 | 70 | 20 |  | 20 | *-* | - | - | - | - |  | 3.2 | 0 | 20 | 20 | 60 |
| Lovell et al. ([2004](#_ENREF_52)) | 43 | 15.6 |  | CS; AAN | Any alt. |  | 100 | 0 | 0 |  | 0 | - | 0 | - | - | 0 |  | - f | - | - | - | - |
| Macciocchi et al. ([2001](#_ENREF_54)) [after 1st of repeat concussions] | 12  | 19.1 |  | CS; VNIS | Any alt. |  | 100 | 0 | 0 |  | *-* | *-* | - | 42 | 33 | - |  | 1.0 (0) | 0 | 100 | 0 | 0 |
| McClincy et al. ([2006](#_ENREF_60)) | 104 | 16.1 |  | AAN | Any alt. |  | 75 | 15 | 9 |  | 9 | 18 | 22 | - | - | - |  | - | 67 | 33 | 13 | - |
| McCrea et al. ([1998](#_ENREF_64)) | 33 | *-* |  | Sideline assessment/ symptom inventory; AAN | Any alt. |  | 100 | 0 | 0 |  | 0 | *-* | - | - | - | - |  | - | - | - | - | - |
| McCrory et al. ([2000](#_ENREF_65)) | 23 | *-* |  | CNS | Any alt. |  | 26 | 30 | 44 |  | 44 | *-* | - | 100 | 65 | - |  | - | - | - | - | - |
| Mihalik et al. ([2007](#_ENREF_67)) [high school] | 155  | 15.6 |  | MO  | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Mihalik et al. ([2007](#_ENREF_67)) [college] | 26  | 22.1 |  | MO  | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Pellman et al. ([2004](#_ENREF_75)) | 95 | 25.4 |  | CS | Any alt. |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | - | - | - | - |
| Register-Mihalik et al. ([2007](#_ENREF_79)) [no preseason headache] | 258  | 16.7 |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | - | 69 | 23 | 8 | 0.3 |
| Register-Mihalik et al. ([2007](#_ENREF_79)) [preseason headache] | 106  | 16.7 |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | 72 | - | - |  | - | 60 | 25 | 9 | 7 |
| Slobounov et al. ([2007](#_ENREF_85)) | 38 | 21.2 |  | CS; Cantu (2006a) | Exc |  | 100 | 0 | 0 |  | 0 | *-* | - | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Slobounov et al. ([2008](#_ENREF_83)) | 12 | 21.2 |  | CS; [Cantu (2006](#_ENREF_12)) | Exc |  | 100 | 0 | 0 |  | 0 | *-* | - | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Slobounov, Slobounov & Newell ([2006](#_ENREF_84)) | 10 | 19.5 |  | MO | *-* |  | N | N | N |  | *-* | *-* | - | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Slobounov, Tutwiler, et al. ([2006](#_ENREF_86)) | 8 | 21.0 |  | Cantu (2001) | Any alt. |  | *-* | *-* | 0 |  | *-* | *-* | - | - | - | - |  | 0 (0) | 100 | 0 | 0 | 0 |
| Sosnoff et al. ([2008](#_ENREF_87)) | 36 | 21.2 |  | AAN | Any alt. |  | 22 | 67 | 11 |  | 11 | *-* | - | - | - | - |  | - | - | - | - | - |
| Van Kampen et al. ([2006](#_ENREF_90)) | 122 | 16.6 |  | AAN | Any alt. |  | N | N | N |  | 12 | 54 | 2 | - | - | - |  | - | 76 | 14 | 8 | 2 |
| Warden et al. ([2001](#_ENREF_91)) | 14 | 19.0 |  | AAN | Exc |  | 43 | 57 | 0 |  | 0 | - | 0 | 79 | 43 | - |  | - | - | - | - | - |

*Note*. AA = anterograde amnesia; AAN = Quality Standards Subcommittee of the American Academy of Neurology ([1997](#_ENREF_78)); ACRM = American Congress of Rehabilitation Medicine ([1993](#_ENREF_1)); Any alt. = any alteration in level of consciousness; C = post-concussion confusion; CISG = Concussion in Sport Group ([Aubry et al., 2002](#_ENREF_2); [McCrory et al., 2005](#_ENREF_66)); CNS = Congress of Neurological Surgeons ([Committee on Head Injury Nomenclature of the Congress of Neurological Surgeons, 1966](#_ENREF_23)); CoMS = Colorado Medical Society, Sports Medicine Committee ([1991](#_ENREF_22)); CS = clinical signs; D = post-concussion dizziness;Do = post-concussion disorientation; Exc = concussion with LOC or Grade 3 AAN (1997) injuries excluded; H = post-concussion headache; LOC = loss of consciousness; MO = diagnosed by medical officer; N = a system of grading injury severity was not used; NHMRC = National Health and Medical Research Council ([1994](#_ENREF_70)); RA = retrograde amnesia; VNIS = Virginia Neurologic Institute Standards ([Macciocchi, Barth, & Littlefield, 2000](#_ENREF_56)); WHO = World Health Organisation Collaborating Centre Task Force on mild traumatic brain injury ([Borg et al., 2004](#_ENREF_4)).

a For full reference see asterisked (\*) citations in References section below. b Simple concussion = no loss of consciousness, symptom resolution <10 days; Complex concussion = loss of consciousness, symptom resolution >10 days. c Steady = postural stability at 48 hours post-injury; Unsteady = postural instability at 48 hours post-injury. d Good post-injury presentation = no change in neuropsychological function pre- to post-injury, asymptomatic; Poor post-injury presentation = 10≤ point decline in memory score, 10≤ point increase in symptom severity from pre- to post-injury. e Inconsistency between AAN grading and incidence of LOC as per published paper. f Reported no significant difference in baseline scores between those with and without previous concussions.

Table 2

*Effect Size Presented as a Function of Injury Characteristics and Athlete Age Group: measures of speed of information processing administered at first post-injury assessments conducted 1-10 days following concussion.*

| Injury characteristics | Sample size |  | All athletes  |  | Adolescent athletes (≤18 years) |  | Adult athletes (≥19 years) |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |
| Concussed | Controls |  | TSI | *d* | *k*  | *Q* |  | TSI | *d* | *k*  | *Q* |  | TSI | *d* | *k*  | *Q* |
| **All comparison groups** |
| Severity Grading Criteria a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | Grade 1 or 2 only (no LOC) | 127 | 10 |  | 2.2 | -0.17 \* | 5 | 7.51 |  | 1.4 | -0.37 \*\* | 1 | - |  | 2.6 | -0.03 | 3 | 3.03 |
|  | All Grades (including LOC) | 1139 | 514 |  | 2.0 | -0.55 \*\*\* | 24 | 99.16 \*\*\* |  | 2.6 | -0.59 \*\*\* | 4 | 2.68 |  | 2.8 | -0.46 \*\*\* | 9 | 15.95 \* |
| Severity Grading Criteria (AAN only) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Grade 1 or 2 only (no LOC) | 0 | 0 |  | - | - | - | - |  |  |  |  |  |  |  |  |  |  |
|   | Grade 3 (LOC) | 525 | 90 |  | 2.2 | -0.56 \*\*\* | 12 | 67.26 \*\*\* |  |  |  |  |  |  |  |  |  |  |
| **Pre-injury baseline comparisons** |
| Severity Grading Criteria a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | Grade 1 or 2 only (no LOC) | 117 | 0 |  | 2.4 | -0.15 \* | 4 | 5.47 |  | 1.4 | -0.37 \*\* | 1 | - |  | 3.1 | 0.00 | 2 | 0.00 |
|  | All Grades (including LOC) | 804 | 0 |  | 2.0 | -0.57 \*\*\* | 15 | 84.29 \*\*\* |  | 2.2 | -0.61 \*\*\* | 1 | - |  | 1.5 | -0.63 \*\*\* | 5 | 9.14 |
| Severity Grading Criteria (AAN only) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Grade 1 or 2 only (no LOC) | 0 | 0 |  | - | - | - | - |  |  |  |  |  |  |  |  |  |  |
|   | Grade 3 (LOC) | 450 | 0 |  | 2.1 | -0.54 \*\*\* | 9 | 64.8 \*\*\* |  |  |  |  |  |  |  |  |  |  |
| **Independent control group comparisons** |
| Severity Grading Criteria a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | Grade 1 or 2 only (no LOC) | 10 | 10 |  | 1.5 | -0.83 | 1 | - |  | - | - | - | - |  | 1.5 | -0.83 | 1 | - |
|  | All Grades (including LOC) | 335 | 514 |  | 2.2 | -0.41 \*\*\* | 9 | 10.94 |  | 2.7 | -0.53 \*\* | 3 | 2.47 |  | 2.1 | -0.25 \* | 4 | 1.09 |
| Severity Grading Criteria (AAN only) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Grade 1 or 2 only (no LOC) | 0 | 0 |  | - | - | - | - |  |  |  |  |  |  |  |  |  |  |
|   | Grade 3 (LOC) | 75 | 90 |  | 2.4 | -0.75 \*\*\* | 3 | 0.87 |  |  |  |  |  |  |  |  |  |  |

*Note.* AAN = Quality Standards Subcommittee of the American Academy of Neurology (1997); *d* = weighted mean effect size. *k* = number of independent sample effect sizes; LOC = loss of consciousness; *Q* = test of homogeneity of effect size variance; TSI = average time elapsed since injury (in days).

a Reported injury severity reclassified according to AAN (1997) criteria on the basis of the presence or absence of LOC within the concussed sample. Any sample included in ‘Grade 1 or 2 only’ was not included in ‘All Grades’.

\* p < .05, \*\* p < .01, \*\*\* p < .001

Table 3

Meta-Regression of Injury Severity Markers*: neuropsychological outcome measures administered at first post-injury assessments conducted 1-10 days following concussion.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Injury Characteristics | Sample size |  | Sample Incidence |  | Regression results |
| *k* | Concussed | Controls |  | *M* (%) | Range (%) |  | Intercept | Slope | 95% CILower; Upper | Q*M* | *QR* |
| **All comparison groups** |
| Post-concussion signs |  |  |  |  |  |  |  |  |  |  |  |  |
| Loss of consciousness a | 29 | 1204 | 531 |  | 15.5 | 0-100 |  | -0.394 \*\*\* | -0.013 \*\*\* | -0.019, -0.006 | 13.79 \*\*\* | 139.11 \*\*\* |
| Retrograde amnesia | 12 | 765 | 343 |  | 23.7 | 5-54 |  | -0.454 \*\*\* | -0.006 \*\* | -0.011, -0.002 | 7.38 \*\* | 88.02 \*\*\* |
| Anterograde amnesia | 18 | 976 | 441 |  | 22.2 | 0-51 |  | -0.472 \*\*\* | -0.005 \* | -0.011, -0.0003 | 4.25 \* | 107.76 \*\*\* |
| a Adolescent samples | 5 | 294 | 163 |  | 12.8 | 0-35 |  | -0.453 \*\*\* | -0.013 \*\*\* | -0.025, -0.002 | 5.18 \* | 9.63 \* |
| a Adult samples  | 14 | 439 | 242 |  | 18.6 | 0-100 |  | -0.205 \* | -0.011 \* | -0.021, -0.001 | 4.39 \* | 24.63 \* |
| **Pre-injury baseline comparisons** |
| Post-concussion signs |  |  |  |  |  |  |  |  |  |  |  |  |
| Loss of consciousness b | 17 | 683 | 0 |  | 17.1 | 0-100 |  | -0.304 \*\*\* | -0.22 \*\*\* | -0.031, -0.014 | 28.20 \*\*\* | 104.50 \*\*\*  |
| Retrograde amnesia | 7 | 403 | 0 |  | 18.4 | 5-27 |  | 0.096  | -0.039 \*\*\* | -0.051, -0.026 | 36.23 \*\*\* | 50.39 \*\*\* |
| Anterograde amnesia | 11 | 536 | 0 |  | 19.5 | 0-37 |  | -0.146 | -0.025 \*\*\* | -0.033, -0.016 | 32.02 \*\*\* | 95.30 \*\*\* |
| b Adolescent samples | 2 | 179 | 0 |  | 7.4 | 0-15 |  | - | - | - | - | - |
| b Adult samples  | 7 | 196 | 0 |  | 24.2 | 0-100 |  | -0.241 \* | -0.019 \*\* | -0.031, -0.006 | 9.02 \*\* | 13.07 \* |
| **Independent control group comparisons** |
| Post-concussion signs |  |  |  |  |  |  |  |  |  |  |  |  |
| Loss of consciousness c | 12 | 521 | 531 |  | 13.3 | 0-35 |  | -0.596 \*\*\* | 0.005 | -0.007, 0.017 | 0.77 | 18.70 \* |
| Retrograde amnesia | 5 | 362 | 343 |  | 31.0 | 7-54 |  | -0.233  | -0.008 \* | -0.015, -0.001 | 5.25 \* | 1.53 |
| Anterograde amnesia | 7 | 440 | 441 |  | 26.7 | 2-51 |  | -0.617 \*\*\* | 0.007  | -0.000, 0.013 | 3.82 | 11.58 \* |
| c Adolescent samples | 3 | 115 | 163 |  | 16.4 | 0-35 |  | -0.683 \*\* | 0.002 | -0.015, 0.019 | 0.07 | 0.15 |
| c Adult samples  | 7 | 243 | 242 |  | 13.0 | 0-25 |  | -0.238 | 0.000 | -0.019, 0.020 | 0.00 | 4.06 |

\* *p* < .05, \*\* *p* < .01, \*\*\* *p* < .001

Table 4

Meta-Regression of Injury Severity Markers*: measures of speed of information processing administered at first post-injury assessments conducted 1-10 days following concussion.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Injury Characteristics | Sample size |  | Sample Incidence |  | Regression results |
| *k* | Concussed | Controls |  | *M* (%) | Range (%) |  | Intercept | Slope | 95% CILower; Upper | Q*M* | *QR* |
| **All comparison groups** |
| Post-concussion signs |  |  |  |  |  |  |  |  |  |  |  |  |
| Loss of consciousness a | 27 | 1,136 | 503 |  | 16.7 | 0-100 |  | -0.358 \*\*\* | -0.011 \*\* | -0.018, -0.004 | 10.57 \*\* | 119.64 \*\*\* |
| Retrograde amnesia | 11 | 701 | 319 |  | 24.0 | 5-54 |  | -0.482 \*\*\* | -0.002 | -0.006, 0.002 | 1.46 | 73.03 \*\*\* |
| Anterograde amnesia | 17 | 912 | 417 |  | 21.9 | 0-51 |  | -0.467 \*\*\* | -0.003 | -0.008, 0.002 | 1.35 | 73.97 \*\*\* |
| a Adolescent samples | 4 | 230 | 139 |  | 16.0 | 0-35 |  | -0.380 \*\* | 0.003 | -0.009, 0.014 | 0.19 | 4.34 |
| a Adult samples  | 13 | 435 | 238 |  | 20.0 | 0-100 |  | -0.153 | -0.012 \* | -0.022, -0.003 | 6.33 \* | 24.45 \* |
| **Pre-injury baseline comparisons** |
| Post-concussion signs |  |  |  |  |  |  |  |  |  |  |  |  |
| Loss of consciousness b | 17 | 683 | 0 |  | 17.1 | 0-100 |  | -0.256 \*\*\* | -0.021 \*\*\* | -0.029, -0.013 | 26.40 \*\*\* | 90.82 \*\*\* |
| Retrograde amnesia | 7 | 403 | 0 |  | 18.4 | 5-27 |  | -0.099 | -0.024 \*\*\* | -0.035, -0.013 | 19.20 \*\*\* | 50.03 \*\*\* |
| Anterograde amnesia | 11 | 536 | 0 |  | 19.5 | 0-37 |  | -0.228 \* | -0.016 \*\*\* | -0.024, -0.008 | 13.69 \*\*\* | 51.35 \*\*\* |
| b Adolescent samples | 2 | 179 | 0 |  | 7.4 | 0-15 |  | - | - | - | - | - |
| b Adult samples  | 7 | 196 | 0 |  | 24.2 | 0-100 |  | -0.118 | -0.021 \*\*\* | -0.032, -0.009 | 12.33 \*\*\* | 15.91 \*\* |
| **Independent control group comparisons** |
| Post-concussion signs |  |  |  |  |  |  |  |  |  |  |  |  |
| Loss of consciousness c | 10 | 453 | 503 |  | 15.9 | 0-35 |  | -0.670 \*\*\* | 0.012 | -0.001, 0.025 | 3.55  | 9.31 |
| Retrograde amnesia | 4 | 298 | 319 |  | 33.8 | 7-54 |  | -0.252 | -0.005 | -0.012, 0.002 | 2.05 | 0.60 |
| Anterograde amnesia | 6 | 376 | 417 |  | 26.2 | 2-51 |  | -0.533 \*\*\* | 0.006 | -0.000, 0.012 | 3.29 | 5.19 |
| c Adolescent samples | 2 | 51 | 139 |  | 24.7 | 14.3-35 |  | - | - | - | - | - |
| c Adult samples  | 6 | 239 | 238 |  | 15.1 | 0-25 |  | -0.453 \* | 0.009 | -0.012, 0.031 | 0.71 | 1.82 |

\* *p* < .05, \*\* *p* < .01, \*\*\* *p* < .001

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