QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

MICHALSKA, Maria, KAŁUŻNY, Tomasz, DAMIAN, Jan, MARKIEWICZ-ZAHORSKI, Magdalena, JASZCZYŃSKA, Julia, KĘSKA, Filip, GOTI, Zoja and ŁUBNIEWSKA, Zofia. Visual and Oculomotor Dysfunction After Sport-Related Concussion: A Narrative Review. Quality in Sport. 2026;72:75306. https://doi.org/10.12775/QS.2026.72.75306

ARTICLE TIMELINE
Received: 13.08.2026. Revised: 30.08.2026. Accepted: 07.09.2026. Published: 16.09.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).
Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

Visual and Oculomotor Dysfunction After Sport-Related Concussion: A Narrative Review

Maria Michalska[1], ORCID: https://orcid.org/0009-0009-8897-9009

E-mail: marysiam30@wp.pl

[1]Jagiellonian University Medical College, Krakow, Poland

Tomasz Kałużny[1], ORCID: https://orcid.org/0009-0006-7462-1688

E-mail: t.j.kaluzny@gmail.com

[1]Jagiellonian University Medical College, Krakow, Poland

Jan Damian[1], ORCID: https://orcid.org/0009-0001-5141-1964

E-mail: jandamian11@wp.pl

[1]Jagiellonian University Medical College, Krakow, Poland

Magdalena Markiewicz-Zahorski[1], ORCID: https://orcid.org/0009-0002-2321-3204
E-mail: magdalena.markiewicz-zahorski@student.uj.edu.pl
[1]Jagiellonian University Medical College, Krakow, Poland

Julia Jaszczyńska[1], ORCID: https://orcid.org/0009-0001-7779-6831
E-mail: jaszczynska.julia@gmail.com
[1]Jagiellonian University Medical College, Krakow, Poland

Filip Kęska[1], ORCID: https://orcid.org/0009-0007-8666-2134
E-mail: f.keska@student.uj.edu.pl
[1]Jagiellonian University Medical College, Krakow, Poland

Zoja Goti[1], ORCID: https://orcid.org/0009-0009-4932-1298
E-mail: zoja.goti@gmail.com
[1]Jagiellonian University Medical College, Krakow, Poland

Zofia Łubniewska[1], ORCID: https://orcid.org/0009-0007-2467-3233
E-mail: zosialubnie@gmail.com
[1]Jagiellonian University Medical College, Krakow, Poland

Corresponding Author

Maria Michalska, E-mail: marysiam30@wp.pl

Abstract

Background. Sport-related concussion (SRC) disrupts visual and oculomotor systems that depend on extended, timing-critical neural circuitry, yet ophthalmological expertise remains under-represented in concussion pathways.

Aim. To synthesise evidence on the mechanisms, phenotypes, assessment, prognosis and rehabilitation of post-concussive vision and eye-movement dysfunction.

Material and methods. A narrative review of MEDLINE/PubMed (2011–2026) combined concussion terms with vision, oculomotor function, convergence, vestibulo-ocular reflex, pupillometry and rehabilitation, prioritising consensus statements, systematic reviews, randomised trials and cohorts.

Results. Vision or vestibular problems affect up to 88% of children in specialist concussion care, and 69% of concussed adolescents carry a vision diagnosis; accommodative dysfunction, convergence insufficiency and saccadic dysfunction predominate. The Vestibular/Ocular Motor Screening and King-Devick test (pooled sensitivity 86%, specificity 90%) add value, but neither is diagnostic alone and accuracy declines with time. Oculomotor symptom provocation predicts protracted recovery. Sub-symptom-threshold aerobic exercise and cervicovestibular rehabilitation have randomised support; vision therapy evidence is preliminary.

Conclusions. Structured vision assessment should be embedded in concussion pathways, with ophthalmological referral for persistent deficits rather than reliance on symptom report alone.

Key words: sport-related concussion; oculomotor dysfunction; convergence insufficiency; vestibular/ocular motor screening; King-Devick test; vision therapy; return to sport; sports ophthalmology

1. Introduction

Concussion is among the most consequential injuries in contemporary sport, and its management has evolved rapidly across successive international consensus processes, most recently the 6th International Conference on Concussion in Sport in Amsterdam (Patricios et al. 2023). Clinical attention has centred on cognition, balance and symptom burden, while the visual system has occupied a peripheral position in sideline and clinic protocols.

This is a striking omission. Vision encompasses a large proportion of the brain's neural pathways, and eye-movement control depends on an extended network spanning the brainstem, cerebellum, thalamus, parietal and frontal cortices, and the long white-matter tracts connecting them (Galetta et al. 2015; Ventura et al. 2016) – precisely the structures most vulnerable to concussive injury. Disorders of vergence, accommodation, saccadic and pursuit control, vestibulo-ocular integration, pupillary regulation and light tolerance are therefore common after sport-related concussion (SRC). They contribute to the symptom burden that keeps athletes out of school and sport, impair reading and screen tolerance during return to learn, and may compromise the perceptual accuracy on which safe return to a collision environment depends. The International Olympic Committee has called for closer collaboration between sports medicine practitioners and ophthalmologists (Moe et al. 2023), yet ophthalmologists are rarely embedded in concussion pathways.

This review addresses six questions: why the visual system is vulnerable; how common dysfunction is after SRC; what phenotypes occur; which assessment instruments are defensible and where they fail; whether oculomotor findings predict recovery; and what can be done therapeutically. Direct ocular trauma and sudden death in sport are not covered, as each merits separate review.

2. Material and methods

This is a narrative (non-systematic) review incorporating a structured search. No formal risk-of-bias appraisal or quantitative pooling was undertaken, because the subject matter spans heterogeneous designs, populations and outcomes, and because the purpose is integrative and translational.

MEDLINE/PubMed was searched for English-language publications from January 2011 to April 2026, combining terms for injury ("brain concussion", "sport-related concussion", "mild traumatic brain injury") with terms for the visual and oculomotor domain ("vision", "oculomotor", "convergence insufficiency", "near point of convergence", "accommodation", "saccades", "vestibulo-ocular reflex", "photophobia", "pupillary light reflex"), instruments ("Vestibular/Ocular Motor Screening", "King-Devick", "SCAT6", "pupillometry") and intervention ("vision therapy", "vestibular rehabilitation", "aerobic exercise", "return to sport"). Priority was given to consensus statements, systematic reviews, randomised trials, prospective athletic cohorts and specialist clinical series, and reference lists of retrieved reviews were hand-searched. Where studies conflict, the discrepancy is stated rather than resolved by preference.

3. Results and state of knowledge

3.1. Why the visual system is vulnerable

Concussion is a functional disturbance arising from a stereotyped neurometabolic cascade. Giza and Hovda (2014) described how biomechanical force produces indiscriminate neuronal depolarisation and unchecked release of excitatory amino acids; restoring ionic homeostasis consumes adenosine triphosphate, precipitating hyperglycolysis followed by reduced cerebral glucose metabolism, alongside mitochondrial dysfunction, altered cerebral blood flow and neuroinflammation. The result is a brain that is metabolically vulnerable and functionally inefficient – a state most conspicuous in systems demanding rapid, precise computation.

Ocular motor control is such a system. Saccades, vergence, accommodation and the vestibulo-ocular reflex depend on long, densely interconnected circuits spanning cortical eye fields, superior colliculus, cerebellum, midbrain and brainstem, whose millisecond-scale timing requires white-matter integrity (Ventura et al. 2016). Rotational acceleration generates shear strain maximal in deep white matter, midbrain and rostral brainstem – the corridor through which much of this circuitry passes. Two mechanisms extend involvement beyond the efferent system: the pupillary light reflex is under dual autonomic control, so post-concussive dysregulation has a measurable ocular expression (Master et al. 2020); and retinal ganglion cell axons, as unmyelinated central nervous system projections, may serve as a biomarker of cumulative neuroaxonal injury (Leong et al. 2018).

3.2. Epidemiology and clinical burden

The population at risk is large. In a systematic review and meta-analysis of elite team contact sports, Prien et al. (2018) reported the highest concussion incidence in rugby match play (3.89 per 1000 hours and 3.00 per 1000 athletic exposures) and the lowest in men's football training (0.01 and 0.08 respectively), with concussion far more frequent in match play than training and female players at increased risk in football and ice hockey.

Estimates of visual involvement vary with setting and, critically, the thoroughness of examination. Master et al. (2016) examined 100 adolescents aged 11–17 years and found 69% had at least one vision diagnosis: accommodative disorders in 51%, convergence insufficiency in 49% and saccadic dysfunction in 29%, with 46% carrying more than one. In 432 paediatric patients aged 5–18 years, Master et al. (2018) found 378 (88%) presented with vision or vestibular problems. These referral-clinic figures overestimate the burden in unselected athletes, but team-based data remain substantial: using a threshold of 6 cm or more, Hutchison et al. (2023) found remote near point of convergence in 22% (95% CI 14–33%) of 68 interuniversity athletes after SRC versus 3% (95% CI 1–7%) of 64 with musculoskeletal injury – a difference of 19% (95% CI 10–30%).

Crucially, this dysfunction is frequently silent on symptom questionnaires. Hutchison et al. (2023) found no relationship between symptom burden and convergence performance, and Storey et al. (2017) concluded that questionnaires may not detect vision symptoms in children. An athlete who denies visual symptoms has not thereby been screened.

3.3. Clinical phenotypes

Receded near point of convergence (NPC) is the most frequently described finding: easy to measure with an accommodative rule and abnormal in a large minority of athletes. Its interpretation is more complicated than routine practice suggests. Among 83 patients under 21 years, more than 28 days post-concussion with chronic symptoms and normal acuity, Raghuram et al. (2019) found receded NPC in 74 (89%), of whom 70 (95%) had an identifiable oculomotor disorder – but only 6 (8%) had convergence insufficiency in isolation, while accommodative disorders alone accounted for 30 (41%) and combined deficits for 21 (28%). A receded NPC is therefore not synonymous with convergence insufficiency, and because treatments differ, affected patients warrant full sensorimotor examination rather than empirical convergence exercises.

Storey et al. (2017) described the natural history in 275 paediatric patients, 67 with abnormal NPC: some recovered with standard care over a median of approximately 4.5 weeks, others after vestibular therapy at a median of 11 weeks, and a small subgroup only after office-based vision therapy at a median of 23 weeks post-injury. Most deficits resolve, but a meaningful minority do not, and those patients accumulate months of disability if the deficit is missed. Howell et al. (2018) showed that NPC abnormality co-occurs with gait deficits, indicating impairment extending beyond the eyes.

Accommodative dysfunction is at least as prevalent but attracts less attention, largely because the most widely used sideline instruments do not assess it. It was the commonest single diagnosis (51%) in the cohort of Master et al. (2016), and abnormal accommodative amplitude predicted prolonged recovery in Master et al. (2018). Clinically it produces blur at near, asthenopia, headache with sustained reading and reduced screen tolerance – precisely the cluster that obstructs return to learn – yet measurement requires only a push-up amplitude test. Saccadic dysfunction, present in 29% of the same cohort, manifests as inaccuracy, increased latency, reduced velocity or symptom provocation during repeated saccades; smooth pursuit may show reduced gain or symptom provocation without frank breakdown, and objective quantification requires instrumentation (Ventura et al. 2016).

The vestibulo-ocular reflex (VOR) and visual motion sensitivity (VMS) domains are the most discriminative components of clinical screening. Mucha et al. (2014) found horizontal VOR (odds ratio 3.89, $p < .001$) and VMS (odds ratio 3.37, $p < .01$) most predictive of concussed status among 64 patients (mean age 13.9 years, assessed a mean of 5.5 days post-injury) and 78 controls. Both are provoked by the visual-vestibular demands of sport itself, so an athlete may be asymptomatic at rest yet symptomatic in a training drill – the question examined by Popovich et al. (2021). Light sensitivity, meanwhile, is among the most commonly reported symptoms and the least well managed; Burstein et al. (2019) reviewed the retinal and central pathways implicated in light-induced discomfort, a framework distinguishing photophobia from simple glare intolerance. Persistent dark adaptation risks reinforcing photophobia rather than relieving it, much as prolonged rest is now recognised to impede recovery.

Quantitative pupillometry is among the most promising objective markers. In 134 controls and 98 adolescent athletes with SRC assessed at a median of 12.0 days post-injury, Master et al. (2020) found eight of nine pupillary metrics significantly greater in the concussed group, including maximum diameter (4.83 vs 4.01 mm) and time to 75% redilation (1.81 vs 1.51 s). Two caveats matter: the effect was enhancement rather than blunting, so a clinician expecting sluggish pupils looks for the wrong abnormality; and exercise in healthy controls produced smaller pupils and overall slowing, mimicking the opposite pattern. Turning to the afferent pathway reframes the question from acute injury to cumulative exposure: Leong et al. (2018) found peripapillary retinal nerve fibre layer thinning of 4.8 µm ($p = 0.01$) among 46 professional collision sport athletes versus 104 controls, most notably in boxers, with reduced 2.5% low-contrast letter acuity ($p = 0.001$).

3.4. Assessment instruments

The Sport Concussion Assessment Tool 6 (SCAT6) is the current standard multimodal instrument (Echemendia et al. 2023), situated within the broader pathway by the Amsterdam consensus (Patricios et al. 2023), with paediatric recommendations from Davis et al. (2024). The salient point is structural: while SCAT6 includes limited ocular observation, it is not a vision examination, and an athlete cleared by a normal sideline screen has not had their visual system examined.

The King-Devick (K-D) test measures speed of rapid number naming, capturing saccadic function together with attention and language. Galetta et al. (2011) administered it before and after competition in 39 boxers and mixed martial arts fighters: post-fight times were markedly worse in those sustaining head trauma (59.1 ± 7.4 s vs 41.0 ± 6.7 s, $p < 0.0001$). A meta-analysis of 15 studies estimated a weighted mean baseline of 43.8 s across 1419 athletes, with sensitivity 86% (95% CI 78–92%) and specificity 90% (95% CI 85–93%) (Galetta et al. 2015). More recent data are sobering: in 320 concussed and 1239 non-concussed collegiate athletes, Le et al. (2023) found area under the curve 0.724 at 0–6 hours and 0.701 at 24–48 hours, falling to 0.640 at unrestricted return to play and becoming non-significant when asymptomatic (0.513, $p = .497$); at 80% sensitivity, specificity was only 46% and 41% acutely, and optimal cut-offs were negative, reflecting substantial practice effects. The test therefore performs best within 48 hours and is a screening adjunct rather than a clearance instrument.

The Vestibular/Ocular Motor Screening (VOMS) is the most widely adopted instrument targeting these domains. Mucha et al. (2014) described five domains – smooth pursuit, horizontal and vertical saccades, NPC distance, horizontal VOR and visual motion sensitivity – each scored for symptom provocation on a 0–10 scale. In validation, 61% of concussed patients were positive on at least one item; an NPC distance of 5 cm or greater, and any item score of 2 or greater, increased the probability of correct identification by 38% and 50% respectively, and a model incorporating VOR, VMS, NPC and log-transformed age achieved an area under the curve of 0.89. Elbin et al. (2022) derived change-score cut-offs in 147 adolescents with SRC and 147 controls: a change of 1 or more for individual items, 3 or more overall, and 3 cm or more for NPC, the overall change score reaching an area under the curve of 0.73.

Two limitations require appreciation. The VOMS is predominantly a symptom-provocation instrument rather than a measure of performance; apart from NPC distance it does not quantify how well the eyes move, making it sensitive but vulnerable to effort and expectation. And false positives are common, with premorbid factors such as motion sickness history associated with vestibular findings (Master et al. 2018) – the rationale for change-score approaches and baseline testing. Pupillometry offers objectivity and independence from effort, but requires normative data across age, sex, illumination and exercise state, while optical coherence tomography addresses cumulative rather than acute injury (Leong et al. 2018). The instruments are compared in Table 1.

3.5. Prognostic value

The prognostic dimension may prove more valuable than the diagnostic one, because it identifies at first presentation those who will not follow the expected trajectory. Anzalone et al. (2017) studied 167 patients (mean age 15 ± 2 years) using Cox proportional hazards to relate VOMS findings to time from injury to the start of the return-to-play protocol. Symptom provocation in every domain except NPC ($p = .107$) and accommodation ($p = .234$) was associated with delayed recovery: smooth pursuit (HR 0.65, 95% CI 0.47–0.90), horizontal saccades (0.68, 0.50–0.94), vertical saccades (0.55, 0.40–0.75), horizontal VOR (0.68, 0.49–0.94) and vertical VOR (0.60, 0.44–0.83), the lowest crude hazard ratio being for the composite ocular motor category (0.45, 0.32–0.63).

Master et al. (2018), in their cohort of 432 paediatric patients, found that provocable symptoms with VOR and smooth pursuit, together with abnormal balance and accommodative amplitude, predicted prolonged recovery, concluding that vision assessment must include smooth pursuits, saccades, NPC and accommodative amplitude – a broader panel than most protocols mandate. Sherry et al. (2021) approached this diagnostically in 64 athletes with SRC and 59 matched controls aged 12–20 years: a stepwise logistic regression correctly classified 84.6% of the sample, with symptom inventory ($p = 0.003$) and vestibular/ocular motor provocation ($p < 0.01$) the most sensitive and specific measures.

Two cautions apply. The divergence on the prognostic weight of NPC and accommodation – non-significant in Anzalone et al. (2017), predictive in Master et al. (2018) – likely reflects differences in technique, age and outcome definition, and should not be resolved by selecting the more convenient finding. And these are observational associations: that a finding predicts slower recovery does not establish that treating it accelerates recovery. This caveat applies with equal force to the elevated musculoskeletal injury risk after concussion demonstrated by McPherson et al. (2019).

3.6. Management and rehabilitation

The most robust intervention evidence concerns exercise rather than vision specifically, but it forms the foundation for any rehabilitation discussion. Leddy et al. (2019) randomised 103 adolescent athletes aged 13–18 years presenting within 10 days of SRC to progressive sub-symptom-threshold aerobic exercise ($n = 52$) or a placebo-like stretching programme ($n = 51$). Median recovery was

13 days (IQR 10–18.5) versus 17 (IQR 13–23) respectively (p = .009), with prescription individualised using treadmill exercise tolerance testing. Early graded aerobic exercise is now the default active strategy against which vision-specific interventions must be compared.

Schneider et al. (2014) randomised 31 patients aged 12–30 years with persistent dizziness, neck pain and/or headache to combined cervical spine physiotherapy and vestibular rehabilitation or to postural education, rest and graded exertion. Medical clearance within eight weeks was achieved by 73% (11 of 15) of the intervention group versus 7% (1 of 14) of controls (hazard ratio 3.91, 95% CI 1.34–11.34). The systematic review for the Amsterdam consensus (Schneider et al. 2023) screened 6533 studies and included 13, of which only one was rated high quality, seven acceptable and five at high risk of bias; it concluded that individualised cervicovestibular rehabilitation may reduce time to return to sport for symptoms beyond 10 days, and that vestibular rehabilitation may reduce time to clearance in adolescents. The evidence is genuinely supportive but thin.

Vision therapy for post-concussive vergence and accommodative disorders is widely delivered and poorly evidenced. Scheiman et al. (2017) used objective eye-movement recording to assess vergence after treatment of concussion-related convergence insufficiency, an important methodological step given that most such studies rely on measures susceptible to expectation effects; Santo et al. (2020) systematically reviewed NPC deficits and their treatment. No adequately powered randomised trial has established that vision therapy accelerates recovery relative to active control. This is not evidence of absence – the intervention is biologically plausible and has established efficacy for non-traumatic convergence insufficiency – but it should be offered as a reasonable option for persistent, formally diagnosed deficits rather than as proven treatment.

Photophobia should be managed by graded reintroduction of normal visual environments rather than sustained avoidance, with a defined weaning plan where tinted lenses are used; persistence warrants ophthalmological assessment. Academic accommodations should match the specific diagnosis (Master et al. 2016): accommodative insufficiency calls for enlarged print and reduced near demand, whereas visual motion sensitivity calls for modified movement between classes. Kontos et al. (2020) developed the Concussion Clinical Profiles Screening tool to support a profile-based approach in which vestibular and ocular motor presentations are distinct trajectories requiring distinct interventions (see also Leddy et al. 2021).

3.7. Return to sport and special considerations

Return-to-sport decisions follow a graded, symptom-limited progression, and recovery timelines have been systematically characterised (Putukian et al. 2023). Two considerations support giving visual status independent weight: oculomotor findings predict protracted recovery (Anzalone et al. 2017; Master et al. 2018), and symptom provocation may appear only under exertion (Popovich et al. 2021), making exertional reassessment rational before clearance. Impaired visual processing is also a plausible contributor to post-concussive musculoskeletal injury risk (McPherson et al. 2019; Howell et al. 2018). No study has yet shown that requiring normalisation of oculomotor measures before clearance reduces reinjury: the recommendation to assess is well founded, whereas withholding clearance on oculomotor grounds alone is not yet evidence-based.

Children and adolescents differ in symptom reporting, recovery and normative values, and age-appropriate recommendations exist accordingly (Davis et al. 2024). Female athletes carry higher concussion risk in several sports (Prien et al. 2018), and sex differences have been reported in pupillary metrics (Master et al. 2020); sex-specific normative data remain unavailable for most vision measures, so applying male-derived thresholds to female athletes risks systematic misclassification. Exposure profile also shapes relevance: combat sports generate the highest cumulative burden and the clearest afferent-pathway signal (Galetta et al. 2011; Leong et al. 2018). This review complements sports-ophthalmology work in the physical-culture literature addressing ocular trauma in combat sports (Kozdra et al. 2026), retinal detachment risk in athletes (Jurczyk-Florkiewicz et al. 2026) and modulation of intraocular pressure by physical activity (Jakubowska et al. 2026); where those papers concern direct ocular injury or haemodynamics, this review addresses the visual consequences of head impact transmitted to the brain.

4. Discussion

The evidence supports reorienting concussion care from a predominantly cognitive and vestibular model toward one giving explicit weight to vision. Visual and oculomotor dysfunction is common, frequently silent on symptom inventories, prognostically informative and functionally consequential. Brief instruments add real value, but each has defined psychometric limitations, and the temptation to treat a single abnormal number as diagnostic should be resisted.

Five weaknesses recur. Most prevalence data derive from specialist referral clinics, producing selection bias toward more symptomatic patients. Thresholds are inconsistent – abnormal NPC has been defined at 5 cm, 6 cm and as a 3 cm change – precluding pooling. Few studies incorporate pre-injury baseline vision data, so the proportion of apparent abnormalities that are pre-existing is unknown. Most designs are retrospective or cross-sectional, and the few randomised trials are underpowered and at moderate-to-high risk of bias (Schneider et al. 2023). And most studies come from North American adolescent and collegiate populations, limiting generalisability to adult, elite and non-Western contexts, and to women's sport specifically. This review has its own limitations: the search was restricted to MEDLINE/PubMed and English-language records, without dual screening, risk-of-bias assessment or quantitative synthesis.

The practical implications are nonetheless clear. Clinicians should not rely on symptom report alone; should include a structured vestibular/ocular screen in the sub-acute assessment, interpreted with change scores where a baseline exists; should extend the panel beyond the sideline minimum to include accommodative amplitude; and should treat the King-Devick test as a screening adjunct rather than a clearance instrument. Persistent deficits warrant formal sensorimotor examination, since a receded NPC is not synonymous with convergence insufficiency and treatment differs by diagnosis. Early individualised sub-symptom-threshold aerobic exercise, and cervicovestibular rehabilitation for symptoms persisting beyond ten days, are the interventions with randomised support.

Research priorities follow directly. Adequately powered multicentre trials of vision-specific rehabilitation against active control, with objective vergence and accommodative outcomes, are the most pressing need. Prospective baseline vision data would establish how much post-injury abnormality is genuinely acquired; standardised measurement technique would allow pooling; and sex- and age-stratified normative data are required before individual-level interpretation is defensible. Finally, prospective evaluation is needed of whether incorporating oculomotor criteria into return-to-sport decisions reduces recurrent concussion or musculoskeletal injury.

5. Conclusions

Visual and oculomotor dysfunction is a common, clinically significant and frequently under-recognised consequence of sport-related concussion. Accommodative dysfunction, convergence insufficiency and saccadic dysfunction predominate, and many affected athletes do not spontaneously report visual symptoms, so direct measurement rather than symptom enquiry is required. Brief instruments – principally the VOMS and, within the first 48 hours, the King-Devick test – add value to multimodal assessment, but neither is diagnostic in isolation, and oculomotor findings carry prognostic weight.

The management evidence is more limited than practice implies. Early sub-symptom-threshold aerobic exercise and cervicovestibular rehabilitation are supported by randomised trials, whereas vision therapy is biologically plausible and widely delivered but not established by adequately powered trials. The appropriate posture is therefore neither neglect of the visual system nor uncritical enthusiasm for vision-specific treatment, but structured assessment with clear referral thresholds to ophthalmology or optometry. The call by the International Olympic Committee for closer collaboration remains, on the evidence reviewed here, incompletely answered.

Disclosure

Supplementary Materials. Not applicable.

Author Contributions. Conceptualization: Maria Michalska; methodology: Maria Michalska, Tomasz Kałużny; investigation and literature search: Filip Kęska, Julia Jaszczyńska, Magdalena Markiewicz-Zahorski, Jan Damian; writing—original draft preparation: Maria Michalska, Tomasz Kałużny, Julia Jaszczyńska, Zoja Goti; writing—review and editing: Zofia Łubniewska, Tomasz Kałużny, Zoja Goti; supervision: Maria Michalska. All authors have read and agreed to the published version of the manuscript.

Funding. This research received no external funding.

Institutional Review Board Statement. Not applicable. This study is a review of previously published literature and did not involve humans or animals.

Informed Consent Statement. Not applicable.

Data Availability Statement. Not applicable. All data discussed are available in the cited published sources.

Acknowledgements. Not applicable.

Conflicts of Interest. The authors declare no conflict of interest.

Declaration of generative AI and AI-assisted technologies in the writing process

In preparing this work, the author(s) used Claude Opus 5 (a large language model developed by Anthropic) for the purpose of language editing of the text, and formatting of the bibliography. After using this tool, the author(s) reviewed and edited the content as needed and take full responsibility for the substantive content of the publication.

References

Anzalone, A. J., Blueitt, D., Case, T., McGuffin, T., Pollard, K., Garrison, J. C., Jones, M. T., Pavur, R., Turner, S. and Oliver, J. M. (2017) A positive Vestibular/Ocular Motor Screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescent athletes. The American Journal of Sports Medicine, 45(2), 474–479. https://doi.org/10.1177/0363546516668624

Burstein, R., Noseda, R. and Fulton, A. B. (2019) Neurobiology of photophobia. Journal of Neuro-Ophthalmology, 39(1), 94–102. https://doi.org/10.1097/WNO.0000000000000766

Davis, G. A., Schneider, K. J., Anderson, V., Babl, F. E., Barlow, K. M., Blauwet, C. A., Bressan, S., Broglio, S. P., Emery, C. A., Echemendia, R. J., Gagnon, I., Gioia, G. A., Giza, C. C., Leddy, J. J., Master, C. L., McCrea, M., McNamee, M. J., Meehan, W. P., Purcell, L., Putukian, M., Moser, R. S., Takagi, M., Yeates, K. O., Zemek, R. and Patricios, J. S. (2024) Pediatric sport-related concussion: recommendations from the Amsterdam Consensus Statement 2023. Pediatrics, 153(1), e2023063489. https://doi.org/10.1542/peds.2023-063489

Echemendia, R. J., Brett, B. L., Broglio, S., Davis, G. A., Giza, C. C., Guskiewicz, K. M., Harmon, K. G., Herring, S., Howell, D. R., Master, C., McCrea, M., Naidu, D., Patricios, J. S., Putukian, M., Walton, S. R., Schneider, K. J., Burma, J. S. and Bruce, J. M. (2023) Sport Concussion Assessment Tool 6 (SCAT6). British Journal of Sports Medicine, 57(11), 622–631. https://doi.org/10.1136/bjsports-2023-107036

Elbin, R. J., Eagle, S. R., Marchetti, G. F., Anderson, M., Schatz, P., Womble, M. N., Stephenson, K., Covassin, T., Collins, M. W., Mucha, A. and Kontos, A. P. (2022) Using change scores on the vestibular ocular motor screening (VOMS) tool to identify concussion in adolescents. Applied Neuropsychology: Child, 11(4), 591–597. https://doi.org/10.1080/21622965.2021.1911806

Galetta, K. M., Barrett, J., Allen, M., Madda, F., Delicata, D., Tennant, A. T., Branas, C. C., Maguire, M. G., Messner, L. V., Devick, S., Galetta, S. L. and Balcer, L. J. (2011) The King-Devick test as a determinant of head trauma and concussion in boxers and MMA fighters. Neurology, 76(17), 1456–1462. https://doi.org/10.1212/WNL.0b013e31821184c9

Galetta, K. M., Liu, M., Leong, D. F., Ventura, R. E., Galetta, S. L. and Balcer, L. J. (2015) The King-Devick test of rapid number naming for concussion detection: meta-analysis and systematic review of the literature. Concussion, 1(2), CNC8. https://doi.org/10.2217/cnc.15.8

Giza, C. C. and Hovda, D. A. (2014) The new neurometabolic cascade of concussion. Neurosurgery, 75(Suppl. 4), S24–S33. https://doi.org/10.1227/NEU.0000000000000505

Howell, D. R., O'Brien, M. J., Raghuram, A., Shah, A. S. and Meehan, W. P. (2018) Near point of convergence and gait deficits in adolescents after sport-related concussion. Clinical Journal of Sport Medicine, 28(3), 262–267. https://doi.org/10.1097/JSM.0000000000000439

Hutchison, M. G., Di Battista, A. P., Pyndiura, K., Blanc, S., Quaid, P. T. and Richards, D. (2023) Incidence of remote near-point of convergence in university athletes after sport-related concussion. Clinical Journal of Sport Medicine, 33(3), 258–263. https://doi.org/10.1097/JSM.0000000000001102

Jakubowska, M., Dziegciarczyk, A., Włodarczyk, A., Wiater, Z., Brankowska, K., Swoboda, K., Domagała, S., Olejnik, M., Kądziołka, W. and Górka, A. P. (2026) Physical activity as a modulator of intraocular pressure: relevance for sport participation and eye health. Quality in Sport, 53, 69807. https://doi.org/10.12775/QS.2026.53.69807

Jurczyk-Florkiewicz, W., Bajor, G., Gniadek, Z., Pszczółka, A., Kozak, J., Melka, K., Szulewski, M., Salagierska, A., Machno, P. and Matuszczak, P. (2026) Retinal detachment risk among athletes: incidence, predisposing factors and preventive strategies. Quality in Sport, 51, 68208. https://doi.org/10.12775/QS.2026.51.68208

Kontos, A. P., Elbin, R. J., Trbovich, A., Womble, M., Said, A., Sumrok, V. F., French, J., Kegel, N., Puskar, A., Sherry, N., Holland, C. and Collins, M. (2020) Concussion Clinical Profiles Screening (CP Screen) tool: preliminary evidence to inform a multidisciplinary approach. Neurosurgery, 87(2), 348–356. https://doi.org/10.1093/neuros/nyz545

Kozdra, B., Olszok, M., Karbowiak, K., Makselan, N., Nawrat, N., Handzel, H., Antczyk, A., Wijas, D. and Kluś, M. (2026) Eye injuries in combat sports – literature review. Quality in Sport, 54, 70126. https://doi.org/10.12775/QS.2026.54.70126

Le, R. K., Ortega, J., Chrisman, S. P., Kontos, A. P., Buckley, T. A., Kaminski, T. W., Meyer, B. P., Clugston, J. R., Goldman, J. T., McAllister, T., McCrea, M., Broglio, S. P. and Schmidt, J. D. (2023) King-Devick sensitivity and specificity to concussion in collegiate athletes. Journal of Athletic Training, 58(2), 97–105. https://doi.org/10.4085/1062-6050-0063.21

Leddy, J. J., Haider, M. N., Ellis, M. J., Mannix, R., Darling, S. R., Freitas, M. S., Suffoletto, H. N., Leiter, J., Cordingley, D. M. and Willer, B. (2019) Early subthreshold aerobic exercise for sport-related concussion: a randomized clinical trial. JAMA Pediatrics, 173(4), 319–325. https://doi.org/10.1001/jamapediatrics.2018.4397

Leddy, J. J., Haider, M. N., Noble, J. M., Rieger, B., Flanagan, S., McPherson, J. I., Shubin-Stein, K., Saleem, G. T., Corsaro, L. and Willer, B. (2021) Management of concussion and persistent post-concussive symptoms for neurologists. Current Neurology and Neuroscience Reports, 21(12), 72. https://doi.org/10.1007/s11910-021-01160-9

Leong, D., Morettin, C., Messner, L. V., Steinmetz, R. J., Pang, Y., Galetta, S. L. and Balcer, L. J. (2018) Visual structure and function in collision sport athletes. Journal of Neuro-Ophthalmology, 38(3), 285–291. https://doi.org/10.1097/WNO.0000000000000572

Master, C. L., Master, S. R., Wiebe, D. J., Storey, E. P., Lockyer, J. E., Podolak, O. E. and Grady, M. F. (2018) Vision and vestibular system dysfunction predicts prolonged concussion recovery in children. Clinical Journal of Sport Medicine, 28(2), 139–145. https://doi.org/10.1097/JSM.0000000000000507

Master, C. L., Podolak, O. E., Ciuffreda, K. J., Metzger, K. B., Joshi, N. R., McDonald, C. C., Margulies, S. S., Grady, M. F. and Arbogast, K. B. (2020) Utility of pupillary light reflex metrics as a physiologic biomarker for adolescent sport-related concussion. JAMA Ophthalmology, 138(11), 1135–1141. https://doi.org/10.1001/jamaophthalmol.2020.3466

Master, C. L., Scheiman, M., Gallaway, M., Goodman, A., Robinson, R. L., Master, S. R. and Grady, M. F. (2016) Vision diagnoses are common after concussion in adolescents. Clinical Pediatrics, 55(3), 260–267. https://doi.org/10.1177/0009922815594367

McPherson, A. L., Nagai, T., Webster, K. E. and Hewett, T. E. (2019) Musculoskeletal injury risk after sport-related concussion: a systematic review and meta-analysis. The American Journal of Sports Medicine, 47, 1754–1762. https://doi.org/10.1177/0363546518785901

Moe, M. C., Özmert, E., Baudouin, C., Binadra, A., Crafoord, S., Jo, Y., Kiratli, H., Moore, M., Pitsiladis, Y. P., Rolle, U., Tan, B., Yanik, Ö., Budgett, R., Erdener, U., Steffen, K. and Engebretsen, L. (2023) International Olympic Committee (IOC) consensus paper on sports-related ophthalmology issues in elite sports. BMJ Open Sport and Exercise Medicine, 9(3), e001644. https://doi.org/10.1136/bmjsem-2023-001644

Mucha, A., Collins, M. W., Elbin, R. J., Furman, J. M., Troutman-Enseki, C., DeWolf, R. M., Marchetti, G. and Kontos, A. P. (2014) A brief Vestibular/Ocular Motor Screening (VOMS) assessment to evaluate concussions: preliminary findings. The American Journal of Sports Medicine, 42(10), 2479–2486. https://doi.org/10.1177/0363546514543775

Patricios, J. S., Schneider, K. J., Dvorak, J., Ahmed, O. H., Blauwet, C., Cantu, R. C., Davis, G. A., Echemendia, R. J., Makdissi, M., McNamee, M., Broglio, S., Emery, C. A., Feddermann-Demont, N., Fuller, G. W., Giza, C. C., Guskiewicz, K. M., Hainline, B., Iverson, G. L., Kutcher, J. S., Leddy, J. J., Maddocks, D., Manley, G., McCrea, M., Purcell, L. K., Putukian, M., Sato, H., Tuominen, M. P., Turner, M., Yeates, K. O., Herring, S. A. and Meeuwisse, W. (2023) Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport – Amsterdam, October 2022. British Journal of Sports Medicine, 57(11), 695–711. https://doi.org/10.1136/bjsports-2023-106898

Popovich, M., Almeida, A., Lorincz, M., Eckner, J. T., Freeman, J., Streicher, N. and Alsalaheen, B. (2021) Does exercise increase vestibular and ocular motor symptom detection after sport-related concussion? Journal of Neurologic Physical Therapy, 45(3), 214–220. https://doi.org/10.1097/NPT.0000000000000356

Prien, A., Grafe, A., Rössler, R., Junge, A. and Verhagen, E. (2018) Epidemiology of head injuries focusing on concussions in team contact sports: a systematic review. Sports Medicine, 48(4), 953–969. https://doi.org/10.1007/s40279-017-0854-4

Putukian, M., Purcell, L., Schneider, K. J., Black, A. M., Burma, J. S., Chandran, A., Boltz, A., Master, C. L., Register-Mihalik, J. K., Anderson, V., Davis, G. A., Fremont, P., Leddy, J. J., Maddocks, D., Premji, Z., Ronksley, P. E., Herring, S. and Broglio, S. (2023) Clinical recovery from concussion – return to school and sport: a systematic review and meta-analysis. British Journal of Sports Medicine, 57, 798–809. https://doi.org/10.1136/bjsports-2022-106682

Raghuram, A., Cotter, S. A., Gowrisankaran, S., Kanji, J., Howell, D. R., Meehan, W. P. and Shah, A. S. (2019) Postconcussion: receded near point of convergence is not diagnostic of convergence insufficiency. American Journal of Ophthalmology, 206, 235–244. https://doi.org/10.1016/j.ajo.2019.04.008

Santo, A. L., Race, M. L. and Teel, E. F. (2020) Near point of convergence deficits and treatment following concussion: a systematic review. Journal of Sport Rehabilitation, 29, 1179–1193. https://doi.org/10.1123/jsr.2019-0428

Scheiman, M. M., Talasan, H., Mitchell, G. L. and Alvarez, T. L. (2017) Objective assessment of vergence after treatment of concussion-related CI: a pilot study. Optometry and Vision Science, 94(1), 74–88. https://doi.org/10.1097/OPX.0000000000000936

Schneider, K. J., Meeuwisse, W. H., Nettel-Aguirre, A., Barlow, K., Boyd, L., Kang, J. and Emery, C. A. (2014) Cervicovestibular rehabilitation in sport-related concussion: a randomised controlled trial. British Journal of Sports Medicine, 48(17), 1294–1298. https://doi.org/10.1136/bjsports-2013-093267

Schneider, K. J., Critchley, M. L., Anderson, V., Davis, G. A., Debert, C. T., Feddermann-Demont, N., Gagnon, I., Guskiewicz, K. M., Hayden, K. A., Herring, S., Johnstone, C., Makdissi, M., Master, C. L., Moser, R. S., Patricios, J. S., Register-Mihalik, J. K., Ronksley, P. E., Silverberg, N. D. and Yeates, K. O. (2023) Targeted interventions and their effect on recovery in children, adolescents and adults who have sustained a sport-related concussion: a systematic review. British Journal of Sports Medicine, 57(12), 771–779. https://doi.org/10.1136/bjsports-2022-106685

Sherry, N. S., Fazio-Sumrok, V., Sufrinko, A., Collins, M. W. and Kontos, A. P. (2021) Multimodal assessment of sport-related concussion. Clinical Journal of Sport Medicine, 31(3), 244–249. https://doi.org/10.1097/JSM.0000000000000740

Storey, E. P., Master, S. R., Lockyer, J. E., Podolak, O. E., Grady, M. F. and Master, C. L. (2017) Near point of convergence after concussion in children. Optometry and Vision Science, 94(1), 96–100. https://doi.org/10.1097/OPX.0000000000000910

Ventura, R. E., Balcer, L. J., Galetta, S. L. and Rucker, J. C. (2016) Ocular motor assessment in concussion: current status and future directions. Journal of the Neurological Sciences, 361, 79–86. https://doi.org/10.1016/j.jns.2015.12.010