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Bullock, Garrett S, Ward, Patrick, Impellizzeri, Franco M, Kluzek, Stefan, Hughes, Tom, Hillman, Charles, Waterman, Brian R, Danelson, Kerry, Henry, Kaitlin, Barr, Emily, Healey, Kelsey, Räisänen, Anu M, Gomez, Christina, Fernandez, Garrett, Wolf, Jakob, Nicholson, Kristen F, Sell, Tim, Zerega, Ryan, Dhiman, Paula, Riley, Richard D and Collins, Gary S (2023) Up front and open, shrouded in secrecy, or somewhere in between? A Meta Research Systematic Review of Open Science Practices in Sport Medicine Research. Journal of Orthopaedic and Sports Physical Therapy, 53 (12). pp. 735-747. ISSN 0190-6011

DOI: https://doi.org/10.2519/jospt.2023.12016

Publisher: Journal of Orthopaedic and Sports Physical Therapy

Version: Accepted Version

Downloaded from: https://e-space.mmu.ac.uk/633143/

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Data Access Statement: The reconciled extracted data that form the results in this study are available in the Open Science Framework (https://osf.io/4amek/)

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- 1 Up front and open? Shrouded in secrecy? Or somewhere in between? A Meta Research
- 2 Systematic Review of Open Science Practices in Sport Medicine Research

4 Funding

5 This study received no funding.

67 Conflicts of Interest

- 8 The authors affirm that they have no financial affiliation (including research funding) or
- 9 involvement with any commercial organization that has a direct financial interest in any matter
- 10 included in this manuscript, except as disclosed and cited in the manuscript. Any other conflict of
- 11 interest (i.e., personal associations or involvement as a director, officer, or expert witness) is also
- 12 disclosed and cited in the manuscript.

³

13 Abstract

- 14
- 15 **Objective:** To investigate open science practices in research published in the top five sports
- 16 medicine journals from 01 May 2022 and 01 October 2022.
- 17 **Design:** A meta-research systematic review
- 18 Literature Search: Open science practices were searched in MEDLINE.
- 19 Study Selection Criteria: We included original scientific research published in one of the
- 20 identified top-five sports medicine journals in 2022 as ranked by Clarivate ((1) British Journal of
- 21 Sports Medicine, (2) Journal of Sport and Health Science, (3) American Journal of Sports
- 22 Medicine, (4) Medicine Science Sport and Exercise, and (5) Sports Medicine-Open). Studies
- 23 were excluded if they were systematic reviews, qualitative research, grey literature, or animal or
- 24 cadaver models.
- Data Synthesis: Open science practices were extracted in accordance with the Transparency and
 Openness Promotion (TOP) guidelines and patient and public involvement (PPI).
- 27 **Results:** 243 studies were included. The median number of open science practices in each study
- 28 was 2, out of a maximum of 12 (Range: 0-8; IQR: 2). 234 studies (96%, 95% CI: 94-99%)
- 29 provided an author conflict of interest statement and 163 (67%, 95% CI: 62-73%) reported
- funding. 21 studies (9%, 95% CI: 5-12%) provided open access data. Fifty-four studies (22%,
- 31 95% CI: 17-27%) included a data availability statement and 3 (1%, 95% CI: 0-3%) made code
- available. Seventy-six studies (32%, 95% CI: 25-37%) had transparent materials and 30 (12%,
- 33 95% CI: 8-16) used a reporting guideline. Twenty-eight studies (12%, 95% CI: 8-16%) were pre-
- registered. Six studies (3%, 95% CI: 1-4%) published a protocol. Four studies (2%, 95% CI: 0-
- 35 3%) reported an analysis plan a priori. Seven studies (3%, 95% CI: 1-5%) reported patient and
- 36 public involvement.
- Conclusion: Open science practices in the sports medicine field are extremely limited. The least
 followed practices were sharing code, data, and analysis plans.
- 39
- 40 Key Words: Open Access, Open Code, Study Protocol, Reporting Guideline

41 Introduction

Sports medicine and science research has improved knowledge and practice in preventing and managing medical and injury problems, and improving athlete performance.^{36,56} Nevertheless, the fields have been plagued by poor reporting of study quality and conduct, which holds the fields back.^{4,30,56} Although not an exhaustive list, methodological flaws and misconduct such as 'p-hacking,' hypothesizing after the results are known (HARKing),¹⁴ and coding and statistical errors²⁸ are common, and threaten the validity of study results.^{3,14}

Opaque design, conduct and reporting of studies (including unavailability of protocols, analysis 48 plans, code, and data) allows problems to fester.^{14,23,49} It is often difficult for practitioners and 49 researchers to identify valid findings from well-designed studies, and poor research practice 50 limits the accuracy of aggregated analyses of systematic reviews and meta-analyses.^{53,54} Small 51 sample sizes in datasets from individual teams or organizations do not help,^{7,29,40,41,57} with 52 imprecise estimates and exaggerated effects further confusing readers.^{1,5,13} While data sharing 53 initiatives can overcome sample size barriers, a team's proprietary data are often strongly 54 protected²² and not shared. 55

Open science is a movement to make all materials and results accessible to all levels of society⁶⁵ 56 and encourages scientists the free sharing of protocols and analysis plans, study registration, 57 results, data, and code.³² Open science is more than open access publishing, open science 58 59 practices can improve athlete health and allows fellow scientists to understand, evaluate, replicate, and confirm previous research from transparent methods, open data, and code.^{12,38,64} 60 Open science practices have been comparatively well adopted in the physical and biological 61 sciences.⁵⁶ However, due to patient privacy and confidentiality, these fields do not have the same 62 ethical considerations as the medical sciences.^{6,32,56} In sports medicine and science, adopting 63

open science is further complicated because of competition between clubs and the potential of
 athlete re-identification.¹² Funders and charity organizations increasingly require plans for open
 science practices to be embedded in grant applications for funded sports medicine research.^{6,32,56}

It is unclear to what extent open science practices are adopted in sports medicine and science 68 research. Previous reports have highlighted the need to increase open science practices in 69 sport,^{25,41,61} judged journals' Transparency and Openness Promotion (TOP) factor scores,⁶¹ 70 evaluated data-sharing statements and pre-registration in randomized controlled trials,²⁵ and 71 discussed evidence of poor data sharing practices.⁴¹ Understanding where sports medicine and 72 science is at with open science will help academics, practitioners, journal editors, reviewers, and 73 funding bodies improve open science practices, potentially accelerating collaboration, 74 methodological transparency, and athlete health outcomes.^{8,11,12} 75 The purpose of this study was to investigate of open science practice in research published in the 76 top five sports medicine journals from 01 May 2022 to 01 October 2022. 77

79 Methods

80 The design of this meta research systematic review was informed by previous work by Hardwicke et al.²⁷ This study was reported using Joanna Briggs Institute guidelines for reporting 81 methodology research⁴⁵ and the Preferred Reporting Items for Systematic Reviews and Meta-82 Analyses Protocol (PRISMA-P).⁴³ Evaluation of open science practice was informed by two 83 84 sources: evaluating implementation of the Transparency and Openness Promotion (TOP) guidelines³⁸ and the review by Tennant et al.⁶⁰ which included evaluation of patient public 85 involvement. Our review was prospectively registered on the Open Science Framework 86 (https://osf.io/4amek/). The final draft manuscript was uploaded and made available on the 87 88 medRxiv pre-print server prior to peer review 89 (https://www.medrxiv.org/content/10.1101/2023.03.30.23287959v1). 90 91 *Relevant party involvement (i.e., Patient and public involvement)* 92 The research question was developed by an author working committee of non-academic partners and individuals who had an interest in or were involved in amateur, collegiate and professional 93 94 sport. The working committee included physiotherapists, physicians, sports performance coaches, athletic trainers, as well as statistical and methodological researchers. The working 95 committee met virtually to discuss strategy and study progress, preliminary results and 96 interpretation of findings, and provide input into the plan for dissemination of findings. 97 98 99 Equity, Diversity, and Inclusion 100 After consideration of the necessity to involve relevant parties and collaborators with required

101 expertise, the author team consists of a diverse range of individuals, including students,

102	clinicians, and early, middle, and late career researchers with balance of people who identify as
103	men and women, different age groups, and nationalities.

105 Study eligibility criteria

106 Article inclusion and exclusion criteria are reported in Table 1.

107

Table 1. Article Inclusion and Exclusion Criteria

109

110 Search strategy and journal selection

111 Sports medicine journals were chosen based on Clarivate journal citation rankings. While these

rankings have limitations,^{24,47} this method was chosen to remove author subjectivity, and avoided

113 cherry picking journals. After excluding journals that are focused on systematic reviews (*Sports*

114 Medicine; Exercise Immunology Review) and qualitative research (Qualitative Research in Sport,

115 *Exercise and Health*), the top five journals were (1) *British Journal of Sports Medicine*, (2)

116 Journal of Sport and Health Science, (3) American Journal of Sports Medicine, (4) Medicine

117 Science Sport and Exercise, and (5) Sports Medicine-Open. These five journals were searched

through MEDLINE on October 10, 2022 for all articles published over a six-month time period,

between May 1, 2022 and October 1, 2022 (Appendix 1).

120

121 Study Selection

All reviewers participated in an online training session (led by GB) that provided information for article screening and the data extraction process. A calibration exercise, consisting of reviewer education, a full group grading of one paper, and then independent screening and grading of five papers, followed by discussion was then performed prior to screening. All reviewers were

required to achieve greater than 90% agreement between their screening and the lead authors 126 decisions on the sample of articles prior to official screening. Titles and abstracts were screened 127 independently for eligibility in equal numbers of randomized articles by paired screening groups 128 (PW and FI, TH and CH, KD and KH, EB and KH, AR and CG, GF and JW, TS and RZ). The 129 full-text of eligible studies were then recovered and screened independently by the same 130 screening pairs.⁴⁶ Title and abstract and full-text study disputes were resolved by consensus 131 within each screening pair. If consensus could not be resolved, the lead author (GB) had final 132 resolution on study inclusion or exclusion. Selected full-text articles were retrieved through 133 134 university online library portals. If a study could not be retrieved, the authors were contacted to request full text, and, if required, interlibrary loan with the assistance of a librarian was 135 attempted. If a full-text article could not be retrieved, the study was excluded from the 136 review.^{9,10,46} All screening was performed in Covidence systematic review software (Veritas 137 Health Innovation, Melbourne, Australia). 138

139

140 Data Extraction

Data were extracted by the same screening pairs (PW and FI, TH and CH, KD and KH, EB and 141 142 KH, AR and CG, GF and JW, TS and RZ), entered into a customized electronic database, using the recommended practices of The National Institute for Health and Care Excellence evidence 143 tables.^{44 19} Conflicts were resolved first by consensus, followed by the lead author (GB). A 144 random sample of three articles from each data extraction team were screened and graded by the 145 study leads (GB, GC) for quality control. Data extraction included author details (e.g., first 146 147 author surname, title, study design, journal, month of publication, and sport). Open science methods were extracted in accordance with the TOP guidelines,³⁸ with an additional criterion 148

149	covering patient and public involvement (Table 2). ⁶⁰ Any articles that were electronic		
150	publications ahead of print were extracted and included, but were not scored on open science		
151	criteria that would not be required prior to full publication such as disclosing author conflicts of		
152	reporting funding.		
153	The five journals selected for review were also evaluated on whether the journal required		
154	publications to adhere to open science criteria. Open science data were extracted at the journal		
155	level by the lead authors (GB, GC). The open science data were extracted as a 'yes' or 'no' for		
156	meeting the criteria.		
157	Data Sharing		
158	The reconciled extracted data that form the results in this study are available in the Open Science		
159	Framework (<u>https://osf.io/4amek/</u>).		
160			
161	Table 2. Open Science Practices evaluated in the review (*adapted from the TOP guidelines ³⁸)		
162			
163	Collating, Summarizing and Reporting the Results		
164	Overall screening agreement and quality control agreement were calculated by Cohen's		
165	Weighted Kappa. The proportion of articles meeting each criterion for open science was		
166	calculated along with a 95% confidence interval. To evaluate potential systematic differences in		
167	open science, data were also stratified according to journal, study design and sport. Open science		
168	practices were analyzed by sport as different sports have different cultures, data collection		
169	methods, and different methodological experts heavily involved in these sports. The scientific		
170	training of different content and methodological expertise may explain differences in how they		

171	design, register, and report their findings. Due to small sample size and proportions at or around
172	zero, Clopper-Pearson confidence intervals were calculated for proportions. ⁵¹ Data were
173	summarized and presented as median, range, and interquartile range (IQR) of articles meeting
174	open science practices. A narrative synthesis was performed. All analyses were performed in R
175	4.02 (R Core Team (2021). R: A language and environment for statistical computing. R
176	Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.). The
177	<i>dplyr</i> package was used for cleaning and calculations.

179 Code Sharing

180 Analytical code used to summarize the findings in this paper are available on the Open Science

181 Framework (<u>https://osf.io/4amek/</u>).

183	After removing duplicates, 360 titles and abstracts were identified over the 6-month sample	
184	period for the five sports medicine journals. Through title and abstract screening, we excluded	
185	letters to the editor and other non-primary scientific research. The screening process identified	
186	243 studies that met our inclusion criteria (Figure 1). Overall, the Kappa agreement between	
187	reviewers for data extraction was 0.86 and random sample quality control agreement was 0.98,	
188	which are both deemed as excellent agreement.	
189		
190	Figure 1. PRISMA Flow Diagram	
191		
192	Study Characteristics	
193	Of the 243 included studies, 20 (8%, 95% CI: 5-12%) were included from the British Journal of	
194	Sports Medicine, 5 (2%, 95% CI: 0-7%) from Journal of Sport and Health Science, 112 (46%,	
195	95% CI: 40-53%) from the American Journal of Sports Medicine, 85 (35%, 95% CI: 29-41%)	
196	from Medicine Science Sport and Exercise, and 21 (9%, 95% CI: 5-13%) from Sports Medicine-	
197	Open.	
198		
199	A total of 94 studies (39%, 95% CI: 33-45%) were prospective cohort studies, 58 (24%, 95% CI:	
200	19-30%) retrospective cohort, 32 (13%, 95% CI: 9-18%) cross-sectional, 29 (12%, 95% CI: 8-	
201	17%) were randomized controlled trials, 14 (6%, 95% CI: 3-9%) case-control, 14 (6%, 95% CI:	
202	3-9%) case series, 1 (<1%, 95% CI: 0-2%) quasi-experimental, and 1 (<1%, 95% CI: 0-2%)	
203	economic and decision analysis.	
204		

205	A total of 81 studies (33%, 95% CI: 27-40%) investigated general population exercise, 57 (23%,		
206	95% CI: 18-29%) multiple sports, 51 (21%, 95% CI: 16-27%) general orthopaedics, 15 (6%,		
207	95% CI: 3-10%) running, 10 (4%, 95% CI: 2-7%) baseball, 4 (2%, 95% CI: 1-4%) cycling, 4		
208	(2%, 95% CI: 1-4%) military, 3 (1%, 95% CI: 0-4%) soccer, 3 (1%, 95% CI: 0-4%) swimming		
209	and diving, 2 (1%, 95% CI: 0-3) American football, and 1 (<1%, 95% CI: 0-2%) for individual		
210	sports of basketball, e-sports, handball, lacrosse, motor sports, netball, occupational population		
211	pregnant athletes, rowers, and skiing.		
212			
213	Evaluation of Open Science Practices		
214	One journal (BJSM) encouraged the most open science practices (Table 3), with conflict of		
215	interest statement, funding transparency, data transparency, reporting guidelines, and patient		
216	public involvement. The median number of open science practices met per journal was 3.5		
217	(range: 2-5; IQR: 1).		
218			
219	No studies met all open science practices. The highest rated study (<0.1%, 95% CI: 0-2%) met 8		

out of 12 open science criteria. The median number of open science practices met per study was
2 (range: 0-8; IQR: 2). Please refer to supplementary data (<u>https://osf.io/4amek/</u>) for individual
study evaluations.

223

A total of 234 (96%, 95% CI: 93-98%) reported author conflicts, and 163 (67%, 95% CI: 61-

225 73%) provided details on funding. A total of 21 (9%, 95% CI: 5-13%) provided open access data

- through an embedded link or made data available in the supplementary material. Fifty-four
- 227 (22%, 95% CI: 17-28%) included a data availability statement or signposted where data was
- available. Of these 54 studies, 39 (72 %, 95% CI: 58-84%) reported data was available upon

230	data. Three studies of the 54 that reported data were available upon reasonable request (6%, 95%		
231	CI: 1-15%) provided a link, made available the supplementary material, or highlighted where		
232	open access code was available.		
233			
234	Seventy-six studies (32%, 95% CI: 22-34%) had fully transparent and available materials and		
235	methods. Twenty-eight studies (12%, 95% CI: 8-16%) reported following a reporting guideline.		
236	Of these, 14 (50%, 95% CI: 31-69%) of the RCT studies reported the Consolidated Standards of		
237	Reporting Trials (CONSORT) guidelines, ² 11 (39%, 95% CI: 22-59%) of the observational		
238	studies reported the Strengthening the Reporting of Observational Studies in Epidemiology		
239	(STROBE) guidelines, ⁶² 4 (14%, 95% CI: 4-33%) prediction studies reported the Transparent		
240	reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD)		
241	guidelines, ¹⁸ and 1 (4%, 95% CI: 0-18%) internet survey study reported the Checklist for		
242	Reporting Results of Internet E-Surveys (CHERRIES) guidelines. ²¹ Twenty eight studies (12%,		
243	95% CI: 8-16%) reported preregistration and 6 (3%, 95% CI: 1-5%) published a protocol in an		
244	open access journal or placed it in an open science repository. Four (2%, 95% CI: 0-4%) reporte		
245	the availability of an analysis plan. No studies (0%, 95% CI: 0-2%) were replication studies.		
246	Seven studies (3%, 95% CI: 1-6%) reported patient and public involvement or citizen science.		
247	(Figure 2).		

reasonable request, and 15 (28%, 95% CI: 16-42%) reported a publicly available site to request

248

249 Figure 2. Breakdown of Open Science Practice

250 251 252 253 254 255	Figure 3. Open Sciences Practices by Journal *Replication is not reported as no studies were replication COI = Conflict of Interest. AJSM = American Journal of Sports Medicine, BJSM = British Journal of Sports Medicine, JSHS = Journal of Sport and Health Science, MSSE = Medicine and Science in Sport and Exercise, SMO = Sports Medicine-Open.	
256 257 258 259 260	Figure 4. Open Sciences Practices by Study Design *Replication is not reported as no studies were replication COI = Conflict of Interest	
261 262 263 264 265	Figure 5. Open Sciences Practices by Sport *Replication is not reported as no studies were replication COI = Conflict of Interest	
266	Open Science Practices by Journal	
267	The median number of open science practices met per article for British Journal of Sports	
268	Medicine was 3 (range: 2-8; IQR: 3), the median for Journal of Sport and Health Science was 3	
269	(range: 3-5; IQR: 1), the median for American Journal of Sports Medicine was 1 (range: 1-7;	
270	IQR: 1), the median for Medicine Science Sport and Exercise was 2 (range: 0-6; IQR: 1), and the	
271	median for Sports Medicine-Open was 4 (range: 3-7; IQR: 1).	
272		
273	Greater than 50% of studies published in each journal reported author conflicts and funding. Less	
274	than 40% of studies reported for data citation in each journal, and only two journals (AJSM and	
275	MSSE) had any articles report open access code. The use of reporting guidelines was reported in	
276	25% or less of studies published in each journal. Only studies in two journals (AJSM and BJSM)	
277	reported the availability of statistical analyses plans. Studies in the British Journal of Sports	
278	Medicine were twice as likely to report patient and public involvement (Figure 3; Appendix 2)	
279		

280 Open Science Practices by Study Design

The median number of open science practices met per study for randomized controlled trials was 4 (range: 1-8; IQR: 2), the median for prospective cohorts was 2 (range: 0-6; IQR: 2), the median for retrospective cohorts was 1 (range: 1-4; IQR: 1), the median for case-controls was 2 (range: 1-7; IQR: 2), the median for cross-sectional studies was 2 (range: 1-5; IQR: 3), the median for case series was 1 (range: 1-6; IQR: 0). Economic and decision analyses and quasi-experimental studies both only included one study.

287

All study designs had similar percentage in terms of meeting the open science criteria for author conflicts, funding, data transparency, and analysis and code transparency. Randomized controlled trials had four times greater percentage of studies that used reporting guidelines and five times greater percentage for registering a study. Randomized controlled trials had three times greater percentage for reporting availability of a statistical analysis plan, and five times greater percentage for reporting patient and public involvement (Figure 4; Appendix 2)

294

295 Open Science Practices by Sport

The median number of open science practices met per study for general population exercise was 2 (range: 0-8; IQR: 2), the median for multiple sports was 1 (range: 1-5; IQR: 1), the median for general orthopaedic patients was 2 (range: 1-7; IQR: 1), the median for running was 3 (range: 1-5; IQR: 2), and the median for baseball was 1 (range: 1-3; IQR: 1).

300

All sport, exercise, and orthopaedic population studies demonstrated a similar percentage for

302 meeting open science criterion for author conflicts, funding, data transparency, analysis and code

transparency, study registration, analysis plan, and patient and public involvement. Studies that

- 304 involved patients with orthopaedic conditions had two times greater percentage of using a
- 305 reporting guideline compared to studies that studied investigated sport and exercise populations
- 306 (Figure 5; Appendix 2).

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None of the journals or studies from the top five sports medicine journals in 2022 met all open 309 science practices. One study met 8 out of 11 open science practices, whereas the median number 310 of open science practices met was only two. The overall adherence to open science principles in 311 the sport medicine and research field is extremely low. Open science practices that were least 312 313 likely to be encouraged by journals or practiced in individual studies were sharing of analysis code, sharing data, and the availability of an analysis plan. When stratifying by study design, 314 randomized controlled trials reported adopting the most open science practices criteria, and 315 316 observational studies the least. 317 The low number of open science practices met is comparable to the social sciences,²⁷ 318 biology,^{31,63} and psychology.⁴⁸ The social, biological, and psychological sciences had similarly 319 low adherence to sharing of analysis code, sharing data, and availability of analysis 320 plans.^{26,31,48,63} Economics has very low sharing of code and data.³⁹ 321 322 323 The limited adoption of open science practices makes it challenging to test reproducibility and generalizability of the published research results. An open science initiative replicated 100 324 325 psychological studies that reported 'statistically significant' results, with only 37% reporting positive results after replication.¹⁷ The improbably high prevalence of statistically significant 326 results is detrimental for users of research.⁴¹ False positives (a 'statistically significant' result, 327 328 when in reality no effect exists) might inadvertently justify a risk factor or interventions that

- 329 clinicians and organizations invest time and resources to implementing, with no effect or
- possibly a harmful effect. Without improved and consistent open science uptake and research

integrity, sports medicine research will continue languish with poor generalizability of the dataand low public trust in research findings.

333

Sports medicine and science does poorly in sharing open access analysis code, data, and 334 availability of analytical plans. Freely accessible statistical code and data sharing offers 335 opportunities to other researchers to replicate statistical methods and results,^{15,20} it can also 336 facilitate the reporting of errors,^{11,12} aggregate findings,^{33,55} and combine data from different 337 sources to answer research questions that cannot be answered using single datasets.^{11,12} 338 339 Unavailability of code and data hinders the sports medicine community's ability to confirm results and combine data, to improve cumulative science. ³³ While a number of studies reported 340 their data were available upon request, this statement is woefully inadequate, and has not resulted 341 in increased access to data within the greater scientific literature.³⁴ Thus, the overall prevalence 342 of open data is likely lower than the reported results. 343

344

Randomized controlled trials had modestly better adoption of open science practices compared to 345 other study designs. Randomized controlled trials are required to register protocols before study 346 347 recruitment prior at registries such as clinicaltrials.gov. Many journals require randomized controlled trials (RCTs) to submit Consolidated Standards of Reporting Trials (CONSORT)² 348 checklists at the time of manuscript submission. The stricter study registration and 349 350 methodological reporting of RCTs is due to the inherent risk, and thus patient protection required. Other methodological designs used in sport medicine, most notably observational 351 studies, should require the same registration and methodological rigor, as these studies also 352 inform evidence-based practice.35 353

355	We encourage the sports medicine community and journal editorial boards to make open science	
356	practices a priority before publication. Mandating study registration, availability of protocols,	
357	analytical plans, data, open access code, and requiring reporting author conflicts of interest,	
358	funding, and guideline checklists at submission are low hanging fruit, which can be easily	
359	implemented across all journals. The practices should also be viewed as performing quality	
360	science. ^{16,42} Reporting patient public involvement, also known as citizen science, is an easy	
361	accessible open science practice that can and should be mandated across all journals. While the	
362	may be special concerns about sharing sports medicine data, ^{11,12} these barriers are not	
363	insurmountable, as already shown through other biomedical scientific fields. ^{6,32,56} Potential	
364	solutions include creating synthetic (i.e., simulated) data that mirrors the characteristics of the	
365	actual data, ⁵² creating a gatekeeper warehouse for data access, ⁵⁰ and using federated access (i.e.	
366	data are housed and analyzed only within the data owner's servers). ⁵⁸	
367		
368	Mandating open science practices may increase academic and research work. Open science takes	
369	commitment and support from the scientific, university, journals, and grant funding	
370	organizations. There is little training, funding, or support for sports medicine researchers in open	
371	science skills. ^{37,42} Universities need to support, value and reward researchers who practice open	
372	science. There is no current consensus on the barriers and facilitators or legal ramifications of	
373	open access data within sport, and there is a need and opportunity to engage all relevant parties	

376 Limitations

in this discussion.

377	Only studies published across the top five ranked journals within sports medicine and science in	
378	the Clarivate journal citation rankings were included. This practice has been used in previous	
379	open science meta-research.27 This methodological strategy was employed to reduce bias in	
380	journal selection and increase scientific rigor in selection and analyzing of open science	
381	practices. Our study was a 6-month sample of selected sports medicine and science journals. It is	
382	possible that open science practice in other sports medicine journals may be even more limited,	
383	due to the smaller scientific barriers attributed to lower ranking journals. ⁵⁹ Scoping reviews are	
384	broad in nature, which decreases the precision of specific scientific questions.	
385		
386	Conclusions	
387	Less than 20% of recommended open science practices were currently met by studies published	
388	in the top five sports medicine journals. Replication, sharing code, data, and availability of	
389	analysis plans were the least followed open science practices. Randomized controlled trials had	

better adherence to open science practices compared to observational studies.

391	Key	Points
		1 011105

392 Findings:

- No study published in the top five sports medicine journals in 2022 met all open science
 practices
- The open science practices of providing open access code, data sharing, and the
 availability of an analysis plan were almost non-existent in sports medicine and science
 journals.

398 Implications:

Failing to implement open science practices in sport compromises trust in methods and results, and negatively impacts people who are trying to translate evidence to practice.

401 Caution:

This study only included the top five sports medicine journals in 2022, as ranked by
 Clarivate. Other sports medicine journals may demonstrate different open science
 practices.

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560	Table 1	. Article	Inclusion	and	Exclusion	Criteria
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Inclusion Criteria	Exclusion Criteria		
Studies published in one of the identified top	Systematic reviews, scoping reviews, meta-		
five sports medicine journals ranked by	analysis		
Clarivate journal citation rankings: (1) British			
Journal of Sports Medicine, (2) Journal of			
Sport and Health Science, (3) American			
Journal of Sports Medicine, (4) Medicine			
Science Sport and Exercise, (5) Sports			
Medicine-Open)			
Studies published in special edition journal	Qualitative Research		
issues			
Original scientific research published as a full	Case reports, editorials, letters to the editor		
peer reviewed paper			
Randomized control trials, observational	Grey literature		
studies			
Published in English	Studies using animal and cadaver models		

Open Science Practice	Criterion			
1. Conflict of Interest Statement	Manuscript provides details on any author			
	conflicts of interest.			
2. Funding Statement	Manuscripts describe funding, and the role of			
	any funders.			
3. Data Citation	Manuscript provides details on the			
	provenance of data, with a clear identifier			
	(e.g., digital object identifiers, website, or link			
	to digital repository).			
4. Data Transparency	Manuscript states where any data are			
	available (e.g., in a data sharing statement),			
	such as a data warehouse or repository, and			
	where to access them through an embedded			
	link. May be within manuscript, or as a			
	separate section (i.e., data availability			
	statement).			
5. Analysis Code Transparency	Manuscript includes details on code			
	availability (i.e., in supplementary materials,			
	or has an available link to a repository within			
C Matariala Transmense	the manuscript).			
6. Materials Transparency	Manuscript state where any materials (such as			
	patient reported outcomes or survey			
	questions) are available, e.g., included as an			
7 Design & Analysis Departing Cycidaling	Manuscript cites and alaims use of an			
7. Design & Analysis Reporting Guideline	appropriate reporting guideline			
8 Study Desistration	Monuscripte state study registration number			
8. Study Registration	with an open access database (e.g. Prospero			
	clinicatrials gov)			
9 Study Protocol	Manuscripts states a study protocol was			
y. Study Holocol	available in an open access repository (e.g.			
	Open Science Framework) or published in an			
	open access journal.			
10. Statistical Analysis Plan	Manuscripts states a statistical analysis plan			
	was available in an open access repository			
	(e.g., Open Science Framework) or published			
	in an open access journal.			
11. Patient & Public Involvement	Manuscript describes any patient and public			
	involvement, also known as 'citizen science'.			
12. Replication	Replication studies that explicitly described			
	their aim was replication of validate previous			
	research.			

Table 2. Open Science Practices evaluated in the review (*adapted from the TOP guidelines³⁸)

Open Science Criterion	BJSM	Journal of Sport and Health Science	AJSM	MSSE
Conflict of Interest Statement	Yes	Yes	Yes	Yes
Funding Transparency	Yes	Yes	Yes	Yes
Data Citation	No	No	No	No
Data Transparency	Yes	Yes	No	No
Analysis Code Transparency	No	No	No	No

No

Yes

No*

No

No

Yes

No

Yes

No

No

No

No

No

Yes

No*

No

No

No

No

No

No

No

No

No

566 **Table 3.** Journal Open Science Practices

567 BJSM = British Journal of Sports Medicine

Materials and Method Transparency

Design and Analysis Reporting

Study Protocol Preregistration

Analysis Plan Preregistration

Patient and Public Involvement

Guideline

Study Preregistration

568 AJSM = American Journal of Sports Medicine

569 MSSE = Medicine Science Sport and Exercise

⁵⁷⁰ *Partially met criteria for a specific subset of study designs.

Sport

Medicine-Open

Yes

Yes

No Yes

No

No

No

No

No

No

No