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Rule Design and Regulatory Preparedness in Elite Keirin Olympic Events 2000–2024 and World Championships 2010–2025

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Abstract

This study examines how rule design, evidence and sanction discretion shape elite keirin officiating. Documentary analysis of Union Cycliste Internationale regulations was combined with reconstruction of 43 tournaments: 11 Olympic events from 2000–2024 and 32 World Championship events from 2010–2025. Selected Olympic cases were examined against the applicable provisions. The reconstructed record contains 71 sanctions across 579 heats and 3,170 rider–heat participations, predominantly from secondary results with targeted official verification. Recorded rates were 3.42 per 100 participations through 2016 and 1.37 from 2017–2025; this association cannot identify an amendment effect. The 2016 pacer amendment clarified the passing threshold while retaining mandatory disqualification. Uncertainty about whether that threshold was crossed concerns evidence and does not itself create sanction discretion. Warning accumulation was already regulated before Paris 2024. Awang's applied article and the formal status of Carlin's reported additional warning remain unresolved. Neither these cases nor aggregate national counts establish or exclude nationality bias. The study distinguishes textual precision, fact-finding and sanction selection, and proposes clearer decision records and regulatory preparedness practices whose effectiveness requires evaluation. Its novelty lies in combining rule-design theory with an auditable public-results record to examine contested decisions at the level of the individual provision, contributing to sport-governance and procedural-justice research.

Keywords: Keirin, Officiating, Rules and Standards, Sport Governance, Procedural Justice

Introduction

Officiating decisions are among the few points at which the governance of a sport directly determines a competitive outcome. A false start, a disqualification or a relegation can remove an athlete whose physical and tactical preparation was otherwise complete. Such decisions

are made by officials who must apply rules quickly, often from imperfect vantage points and under the scrutiny of athletes, teams and national audiences (MacMahon et al., 2015; Plessner & Haar, 2006). Research on sports officiating has grown into a substantial literature (Hancock, Bennett, Roaten, Chapman, & Stanley, 2021), much of it concerned with the perceptual, positional and psychological determinants of officials' decisions (Mascarenhas, Collins, & Mortimer, 2005; Plessner & Haar, 2006). Less attention has been paid to how the form of the provision being applied shapes what officials are asked to decide, how consistent their decisions can be and how those decisions are perceived. When the stakes are highest, the legitimacy of officiating depends not only on whether decisions are correct, but also on whether they are seen to be consistent and explained (Tyler, 2006a). Correctness, consistency and perceived legitimacy are distinct properties, and a decision can satisfy one while failing another. Distinguishing them is a precondition for interpreting contested decisions without either dismissing complaints of unfairness or accepting them at face value.

Legal theory on the design of provisions helps to explain how these properties can diverge. Rules specify in advance the conduct that triggers a consequence, whereas standards leave the application of a general criterion to the decision-maker at the time of decision (Kaplow, 1992). A speed limit is a rule, often described as a 'bright line'; a requirement to drive with reasonable care is a standard. The economic analysis of legal rule-making treats the choice between them as a trade-off between the cost of specifying conduct in advance and the cost of evaluating it afterwards (Ehrlich & Posner, 1974; Kaplow, 1992). Rules are more predictable and cheaper to apply, and they limit the scope for a decision-maker's preferences or biases to influence outcomes. Their cost is that they are over- and under-inclusive: they capture conduct that is technically prohibited but harmless in context, and they miss conduct that is harmful but falls outside the specified trigger (Schauer, 1991; Sunstein, 1995). Standards fit the circumstances of the case more closely but are less predictable, more costly to apply and more exposed to inconsistency between decision-makers and to suspicion of bias. Diver (1983) showed that the precision of a rule has several dimensions, including the clarity of its terms (transparency), the ease with which it can be applied to concrete facts (accessibility) and its fit with the purpose it serves (congruence). A provision can therefore be rule-like in its consequence while remaining imprecise in its trigger.

Sports provisions sit at different points on this spectrum. Some define spatial or temporal thresholds; others require an assessment of dangerous or irregular conduct. Even apparently determinate provisions may require interpretation when the text runs out (Russell, 1999). Poor specification can also create unintended incentives (Kendall & Lenten, 2017). Three questions must nevertheless be kept separate: how precisely the text defines prohibited conduct; whether the evidence establishes that the conduct occurred; and whether the consequence is fixed or requires a further assessment of gravity. An official's uncertainty about wheel position concerns evidence, even when the legal threshold and sanction are fixed. It does not, by itself, establish normative discretion. This distinction allows a rule to be criticised for difficult application without misclassifying every factual judgement as a standard.

The form of a provision is, however, only one influence on the decisions made under it. Research on officiating shows that decisions are also shaped by perception, positioning, expectations and the information available to the official at the moment of decision

(MacMahon et al., 2015; Mascarenhas et al., 2005; Plessner & Haar, 2006). Systematic biases have been documented: nationalistic scoring in judged sports (Emerson, Seltzer, & Lin, 2009; Heiniger & Mercier, 2021; Zitzewitz, 2006), referee decisions that respond to crowd pressure (Dohmen & Sauermann, 2016; Pettersson-Lidbom & Priks, 2010), and home advantage that is larger in events where officials have more influence on results (Balmer, Nevill, & Williams, 2003). Technological aids can reduce errors of perception, but they do not remove the need for judgement when the provision being applied is itself a standard (Collins, Evans, & Higgins, 2016; Kolbinger & Lames, 2017). Because bias has been documented in sport, athletes and national audiences may attribute adverse decisions to bias even where none operated, particularly when the beneficiary comes from a dominant nation. These findings concern different sports, officials and decision types, and none establishes the presence, direction or size of any bias in track cycling. Their relevance is that an attribution of bias is available, and it therefore needs to be examined rather than assumed or dismissed.

Whether such an attribution takes hold depends partly on how decisions are made and communicated. The procedural-justice account of legitimacy explains why the perception of a decision can matter as much as its correctness. People accept decisions, including unfavourable ones, as legitimate when the process is perceived to be neutral, consistent and transparent, and when those affected are treated with respect and given reasons (Lind & Tyler, 1988; Tyler, 2006a, 2006b). Organisational-justice research distinguishes this procedural dimension from informational justice, the adequacy of the explanations provided for a decision (Colquitt, 2001). In sport, the 'field-of-play' tradition limits the review of officials' decisions by courts and arbitral bodies, which places the burden of legitimacy on the officiating process itself (Duval, 2013; Foster, 2003). An unexplained difference between two decisions can therefore damage confidence even when both are defensible under the rules. For national programmes, the implication is twofold: athletes must be prepared for the rules as they are applied, and programmes must be equipped to understand, and where appropriate contest, decisions through the channels that the governing body provides.

The distinctions drawn above are clearest in an event where provisions of different form operate side by side and a single decision can settle a result. The keirin provides such a setting. It originated in post-war Japan as a regulated betting sport, where concern for integrity shaped race management (Furukawa, 1997), and entered the Olympic programme for men in 2000 and women in 2012. Under the post-2016 specification on a 250 m track, the pacer accelerates from 30 to 50 km/h and leaves after the pursuit line with three laps remaining (Union Cycliste Internationale [UCI], 2023, 2026, art. 3.2.137). Article 3.2.140 defines a pacer-passing threshold with mandatory disqualification. Other conduct provisions combine spatial restrictions, evaluative criteria and different sanction sequences. Track sprinting places substantial anaerobic demands on riders (Craig & Norton, 2001), while match-sprint research demonstrates the importance of positional and tactical choices (Moffatt, Scarf, Passfield, McHale, & Zhang, 2014; Rysman et al., 2025). Keirin performance research also includes experimental physiological work (Lindsay et al., 2017). Regulation, evidence and tactics therefore interact within a short race, but should not be treated as interchangeable explanations of its outcome.

The literatures reviewed above bear on the same decisions but, in the work located for this study, have largely developed separately. Legal accounts of rule design are seldom applied to

the specific provisions under which sport officials decide; officiating research has concentrated on perception, positioning and bias rather than on the form of those provisions; and published keirin research has addressed mainly the event's history, physiology and tactics. The research problem is therefore how to separate questions of text, evidence and sanction when a keirin decision is contested, and to determine what the accessible public record can and cannot establish about such decisions.

This gap matters because contested outcomes invite competing accounts. Three possible explanations motivate the analysis: nationality bias, differences in the provisions applied, and changes in regulation or its enforcement over time. They are not mutually exclusive. A comparison of bias explanations would require comparable incidents, national exposure denominators, relevant contextual variables and information about the decision process. Those data are not supplied by aggregate sanction counts or a small set of controversies. The present design therefore identifies conditional regulatory interpretations and competing explanations; it neither ranks their causal importance nor tests whether nationality influenced individual decisions.

These competing explanations became publicly salient in the Olympic cases that prompted this study, involving Malaysia's Azizulhasni Awang. The Rio 2016 keirin final was stopped twice and restarted with all six riders; Awang subsequently won bronze (Cyclingnews, 2016a; Olympedia, n.d.). He won silver at Tokyo 2020, held in 2021. At Paris 2024, he was disqualified in the first round, while Jack Carlin continued after a disputed incident in the individual sprint and won bronze. Malaysian public discussion juxtaposed these outcomes (Malay Mail, 2024c). The first author is a Maldivian Olympian and academic based in Malaysia; the co-authors are academics at the same Malaysian university. Professional proximity to the Malaysian setting may have influenced case selection. The analysis therefore states its selection criteria, includes outcomes favourable to Awang, and distinguishes recorded decisions from interested parties' explanations.

To address the research problem set out above, four questions organise the study. How did the pacer rule change after Rio 2016? What sanction patterns appear in Olympic keirin results from 2000–2024 and World Championship results from 2010–2025? How do the rules and available evidence constrain interpretation of the selected Olympic cases? What practices might help national programmes prepare for consequential regulatory decisions? The intended contribution is a reproducible description and a bounded interpretation, together with proposals for practice, rather than a causal evaluation of the amendment or a test of national bias.

Within these bounds, the study's novelty lies in analysing contested officiating decisions at the level of the individual provision, integrating legal accounts of rule design, officiating research and an auditable public-results record. Its contribution to the social sciences is threefold. Conceptually, it applies the rules-versus-standards distinction to sport officiating by separating textual precision, fact-finding and sanction selection, which are easily conflated when decisions are disputed. Methodologically, it provides a reproducible rider–heat reconstruction of 43 Olympic and World Championship keirin tournaments that others can audit and extend. Practically, it connects procedural-justice research to the governance of international sport, showing why identifiable articles and accessible warning records matter

for perceived legitimacy, and it proposes regulatory preparedness practices for national programmes. The approach may transfer to other settings in which consequential decisions are contested but their reasons are not routinely published. The novelty claimed lies in this integration; the study does not claim to be the first or only analysis of keirin officiating.

Methodology

Design and scope

The study combines documentary analysis, a descriptive reconstruction of public results and structured case analysis. These strands were examined separately and integrated at interpretation, drawing on mixed-methods and case-study principles (Creswell & Plano Clark, 2018; Yin, 2018). The documentary unit is the provision; the event unit is one sex-specific keirin tournament in one championship edition; the case unit is a particular officiating incident. The event record covers all 11 Olympic keirin tournaments from 2000–2024 and 32 World Championship tournaments from 2010–2025. The different windows are deliberate: Olympic coverage begins with the event's debut, while the World Championship series is a bounded contemporary comparison beginning in 2010. The study does not represent all World Championships since 2000. No prospective protocol was registered. All quantitative comparisons are exploratory and conditional on the reconstructed records. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement informs transparency (von Elm et al., 2007), without directly validating this design.

Documentary analysis

The regulatory comparison uses the archived March 2014 Part 3 text, the official consolidated text of 1 August 2023, and the 1 January 2026 version (UCI, 2014, 2023, 2026). Relevant passages include arts. 3.2.137–3.2.142, sprint-conduct provisions, historical art. 3.2.013 and arts. 3.10.003–3.10.004. Amendment annotations were read alongside these snapshots; the UCI's October 2016 announcement corroborates the stated clarification of pacer overtaking (UCI, 2016). The 2023 warning text predates Paris and its next amendment is dated 1 January 2025 in the 2026 version. The later wording is not applied retrospectively to Paris. The working penalty list is treated as an aid, not a replacement for regulations (UCI, 2020). Following Bowen (2009), the comparison records textual precision, evidence needed to establish an infringement and discretion in sanction selection separately. It is an interpretive coding exercise; independent human double coding is not claimed. A targeted English-language public-web check on 20 October 2026 used combinations of keirin, officiating, sanctions, rules and standards, and sport governance. It was not a systematic review or a search of subscription bibliographic databases. The query log accompanies the supplementary files, and no exhaustive novelty claim is made.

Reconstruction of heats and recorded sanctions

Event-specific Wikipedia results tables (Wikipedia contributors, 2026) were reconstructed into a rider–heat ledger, with exact URLs, available revision identifiers and retrieval dates recorded in the source register. Olympedia heat records supplied missing sanction annotations for Sydney 2000 and London 2012. The Paris 2024 men's and women's keirin tables were checked against the official results book (Paris 2024, 2024). This is a complete reconstruction of the selected secondary tables, with targeted primary verification, rather than a complete audit against official reports for every edition. A heat is one scheduled contest, including a classification final. A rider–heat participation counts a rider once in that

heat if the rider started any attempt: finishers, riders who did not finish, and riders relegated or disqualified are included; entries marked did not start (DNS) are excluded. A restart does not add another heat or another participation by the same rider. Consequently, this denominator is not a count of physical race starts or time at risk. Summary classifications are not counted again as races. Tokyo retains its 2020 edition label but is coded and plotted at calendar year 2021.

The numerator is a recorded relegation (REL) or disqualification (DQ) attached to a rider and heat. A relegation and resulting second-warning disqualification from the same incident are counted once, using the disqualification outcome; separate sanctions in different heats are retained. Warnings alone are excluded because their reporting is incomplete. Retrospective anti-doping exclusions are excluded from the numerator while actual race participations remain in the denominator. Result codes and legal reasons are separate fields: a DQ label does not establish the article applied or that the rider was excluded from the whole tournament. This is particularly important for the six Sydney 2000 DQ-labelled outcomes, some followed by participation in later rounds. For London 2012, Olympedia's specific relegation annotation for Zhang Miao takes precedence over its generic DQ display. Awang's Paris result remains a DQ with the regulatory article unconfirmed; a pacer-pass interpretation is considered only in the case analysis. Internal checks reconcile all event counts to the heat and rider ledgers. The revision register identifies changes from the earlier compilation, including DNS exclusions, heat totals and an additional recorded relegation of Lin Junhong at the 2016 World Championships.

Statistical analysis

Descriptive rates use 100 rider–heat participations as the denominator. Exact Poisson intervals (Garwood, 1936) and exact conditional rate ratios (Gu, Ng, Tang, & Schucany, 2008) are supplied as assumption-dependent summaries. They do not measure uncertainty in transcription, source completeness or legal classification. The pre-amendment group includes Rio 2016; the post-amendment group begins in 2017. The before–after comparison is repeated for 2010–2025 and for relegations alone, because early DQ labels have limited legal specificity. Event-level Poisson models include competition and sex, with log participations as an offset; quasi-Poisson standard errors use Pearson dispersion (Ver Hoef & Boveng, 2007). These models are exploratory, have small counts and do not fully address dependence within editions.

Step-only, calendar-year-only and combined models are compared using the Akaike information criterion (AIC) of the corresponding Poisson fits. AIC is not assigned to a quasi-likelihood. The 2010–2025 restriction avoids having only Olympic observations in the earliest years. A before–after association cannot identify an amendment effect when formats, reporting practices, technology and other rules may also change (Lopez Bernal, Cummins, & Gasparrini, 2017; Wagner, Soumerai, Zhang, & Ross-Degnan, 2002). Model comparisons therefore describe sensitivity, not competing causal explanations. Numerical results are reproduced with Python, NumPy and SciPy (Virtanen et al., 2020); the script reports software versions. Confidence intervals (CIs) are emphasised, p values are exploratory, and absence of a clear difference is not evidence of equivalence (Altman & Bland, 1995; Wasserstein & Lazar, 2016).

Case analysis

The selected episodes are the Rio 2016 keirin final, the Tokyo 2020 keirin final and the Paris 2024 comparison between Awang's keirin disqualification and Carlin's sprint contest. Selection was purposive and motivated by the public debate, with Tokyo included as a contrasting tactical case (Flyvbjerg, 2006). Each episode was examined for the applicable text, the facts established by results, the explanations reported by participants and the unresolved alternatives. Official result records establish the reported outcome; they establish a legal basis only when an article or sufficiently specific reason is supplied. Media reports and statements by riders or coaches remain attributed accounts. A statement against the speaker's interest may add context, but is not independent confirmation. The Paris analysis explicitly varies the assumed article in Awang's case and the formal status of the reported additional warning in Carlin's case.

Data and computational reproducibility

The supplementary package contains event, heat, rider–heat and sanction comma-separated values (CSV) files; a source register; a correction register; an executable analysis script; and its numerical output. The script checks reconciliation and reproduces all quantitative estimates and Figure 2 from the supplied data. Computational reproducibility is distinguished from source validation: reproducing a number does not establish that a secondary source is complete or legally precise (Sandve, Nekrutenko, Taylor, & Hovig, 2013). Table 1 gives event totals. The source register preserves event-specific URLs and revision identifiers where available, supporting transparent reuse in relation to the Findable, Accessible, Interoperable and Reusable (FAIR) principles without asserting formal certification (Wilkinson et al., 2016).

Table 1
Reconstructed event totals

Comp.	Edition	Event	Heats	Rider–heat participations	REL	DQ	Total
OG	2000	Men	9	52	0	6	6
OG	2004	Men	10	60	6	0	6
OG	2008	Men	12	65	2	0	2
OG	2012	Men	9	54	1	0	1
OG	2012	Women	9	54	0	0	0
OG	2016	Men	12	70	3	0	3
OG	2016	Women	12	70	2	0	2
OG	2020	Men	16	91	1	1	2
OG	2020	Women	16	90	1	0	1
OG	2024	Men	16	89	4	2	6
OG	2024	Women	16	92	0	0	0
WC	2010	Men	12	69	1	2	3
WC	2010	Women	10	60	2	0	2
WC	2011	Men	16	84	2	0	2
WC	2011	Women	12	62	0	0	0
WC	2012	Men	16	84	1	0	1

Comp.	Edition	Event	Heats	Rider–heat participations	REL	DQ	Total
WC	2012	Women	12	60	0	0	0
WC	2013	Men	12	72	4	0	4
WC	2013	Women	9	48	1	1	2
WC	2014	Men	12	59	1	2	3
WC	2014	Women	12	62	1	0	1
WC	2015	Men	12	66	1	0	1
WC	2015	Women	12	62	3	0	3
WC	2016	Men	12	66	0	1	1
WC	2016	Women	12	66	3	0	3
WC	2017	Men	12	72	2	0	2
WC	2017	Women	12	70	0	0	0
WC	2018	Men	16	76	0	0	0
WC	2018	Women	12	64	3	0	3
WC	2019	Men	16	89	2	0	2
WC	2019	Women	16	84	4	0	4
WC	2020	Men	16	88	1	0	1
WC	2020	Women	16	86	0	0	0
WC	2021	Men	12	66	0	0	0
WC	2021	Women	12	58	0	0	0
WC	2022	Men	16	88	0	0	0
WC	2022	Women	16	87	0	0	0
WC	2023	Men	16	88	0	0	0
WC	2023	Women	16	84	2	0	2
WC	2024	Men	16	86	0	0	0
WC	2024	Women	16	80	0	0	0
WC	2025	Men	19	101	1	0	1
WC	2025	Women	16	96	1	0	1

Note. OG = Olympic Games; WC = World Championships; REL = relegation; DQ = disqualification label. Tokyo's calendar year is 2021. DQ labels are not uniform legal classifications; six Sydney 2000 outcomes remain uncertain in their extent. Race-level source records, riders and sanctions appear in the supplementary ledgers. Paris values are checked against the official results book; the broader series remains predominantly secondary-source reconstruction.

Results

The regulatory provisions and the 2016 amendment

Table 2 and Figure 1 distinguish changes in the trigger from changes in the consequence. The archived 2014 text of art. 3.2.140 prohibited passing the pacer's back wheel before departure and required a rerun without the rider at fault, who was disqualified. Article 3.2.137 placed departure at the commissaires' direction, normally 600–700 m from the finish. The

amendment dated 14 October 2016 replaced that reference with the leading edge of the pacer's front wheel before the pursuit line on departure, alongside a three-lap sprint on a 250 m track (UCI, 2014, 2023, 2026). Mandatory disqualification was retained. The UCI's announcement described the overtaking rules as clarified and the sprint as lengthened (UCI, 2016; see also Cycling Weekly, 2016; Cyclingnews, 2016b).

Table 2
Regulatory text and the tasks of the official

Provision	Text and change	Consequence	Judgement required
Pacer departure 3.2.137	2014: commissaire-directed departure, normally 600–700 m to finish. From October 2016: after the pursuit line, three laps to go on a 250 m track.	Defines the departure context.	Assess position, timing and pacer conduct.
Pacer passing 3.2.140	2014: back-wheel threshold before departure. From October 2016: leading edge of front wheel before the pursuit line on departure.	Rerun without rider at fault; disqualification in both texts.	Establish the facts; no graded penalty in this article.
Other conduct behind derny 3.2.142	Fault or unsporting conduct. Consequence amended June 2020.	Earlier: disqualification. From June 2020: relegation with warning or disqualification according to gravity.	Evaluate fault and, under amended text, gravity.
Sprint conduct 3.2.041–3.2.048; 3.2.141	Includes lane and space restrictions and evaluative conduct criteria. Sprint provisions apply to keirin.	Depends on the specific infringement and sanction provisions.	Mixture of factual and evaluative decisions; not uniform discretion.
Warnings before Paris 3.2.013 (2014); 3.10.003 (2023)	2014: second warning or third relegation leads to disqualification. 2023: warnings carry between events in the same competition.	2023: second warning or third relegation excludes rider for the rest of the competition.	Whether to impose a warning may involve judgement; accumulation consequence is prescribed.
Warnings from 2025 3.10.003; 3.10.003bis	Second warning in one event; or three warnings across the competition. Warnings must be recorded in communiqués.	Disqualification as specified in the amended text; third relegation also triggers exclusion.	Verify formal warning history and applicable version. Do not apply the 2025 amendment to Paris.

Note. Paraphrases of UCI (2014, 2023, 2026). The 2023 text and the subsequent amendment annotations inform the Paris comparison. Textual precision, finding facts and selecting sanctions are separate dimensions.



Figure 1 Changes in pacer provisions
Note. Paraphrases of UCI (2014, 2023, 2026). The 2016 change to art. 3.2.140 and the 2020 change to art. 3.2.142 occurred separately. The latter previously prescribed disqualification.

The amendment specified the reference wheel and a fixed track location, increasing textual clarity and making a designated camera view feasible in Diver's (1983) terms. It also changed the geometric threshold, so it was not merely a change of wording. Whether an infringement occurred still requires evidence of relative positions and timing. Article 3.2.142 concerns fault or unsporting conduct behind the derny. Its earlier mandatory disqualification was replaced, in the amendment dated 12 June 2020, by a gravity-dependent choice between relegation with a warning and disqualification (UCI, 2014, 2023, 2026). These changes occurred on different dates and should not be collapsed into a single 2016 reform.

Sprint-conduct provisions, also relevant to keirin under art. 3.2.141, contain both spatial restrictions and evaluative criteria; they are not uniformly discretionary standards. Warning accumulation is explicitly regulated. Article 3.2.013 in the 2014 text provided disqualification on a second warning or third relegation. The 2023 art. 3.10.003 carried warnings between events within a competition and prescribed disqualification for the rest of the competition on a second warning or third relegation. Its 2025 amendment, shown in the 2026 text, distinguishes a second warning within the same event from three warnings across the competition. Article 3.10.003bis also requires warnings to be recorded in commissaires' communiqués. Whether an incident warrants a formal warning can involve judgement; once the applicable accumulation threshold is met, its consequence is prescribed. These written rules make the formal status of Carlin's reported additional warning central to interpreting his case.

Recorded sanctions and the reconstructed denominator
The compilation contains 579 distinct heats and 3,170 rider–heat participations across 43 events (Tables 1 and 3). It records 71 sanctions, of which 56 are relegations (78.9%) and 15 are DQ-labelled outcomes with differing levels of detail about their reason and extent. Twenty-nine events contain at least one recorded sanction. The conditional overall rate is

2.24 per 100 participations (exact Poisson 95% CI 1.75–2.83). These categories describe result records, not a claim that all DQ labels represent the same legal penalty. The Paris reconstruction gives 16 heats and 89 participations for men and 16 heats and 92 participations for women. The men's denominator includes Awang in his first-round heat, excludes Turnbull's final DNS and does not count Ota as starting a final after his semifinal disqualification. These totals demonstrate why scheduled heats, result rows and physical start attempts must be distinguished. No complete series of restart attempts is claimed.

Table 3
Reconstructed event and sanction totals

Group	Events	Heats	Rider–heat participations	Total sanctions (REL; DQ)	Per 100 (95% CI)
All events	43	579	3,170	71 (56; 15)	2.24 (1.75–2.83)
Olympic Games	11	137	787	29 (20; 9)	3.68 (2.47–5.29)
World Championships	32	442	2,383	42 (36; 6)	1.76 (1.27–2.38)
Through Rio 2016	21	244	1,345	46 (34; 12)	3.42 (2.50–4.56)
2017–2025	22	335	1,825	25 (22; 3)	1.37 (0.89–2.02)
Men	23	315	1,735	47 (33; 14)	2.71 (1.99–3.60)
Women	20	264	1,435	24 (23; 1)	1.67 (1.07–2.49)

Note. REL = relegation; DQ = disqualification label in results, not necessarily tournament exclusion. Scheduled heats are counted once; DNS entries are excluded and repeat attempts are not added. Intervals are exact Poisson summaries conditional on the compiled record and do not include source error. CI = confidence interval. Parentheses in the sanctions column give REL and DQ counts, respectively.

Exploratory comparisons over time

The reconstructed record contains 46 sanctions in 1,345 participations through Rio 2016 and 25 in 1,825 participations from 2017–2025 (Figure 2). The corresponding rates are 3.42 and 1.37 per 100 participations; their conditional exact rate ratio is 0.40 (95% CI 0.24–0.67). Competition-specific estimates are 0.53 (0.21–1.21) for the Olympics and 0.39 (0.19–0.75) for the World Championships. The adjusted quasi-Poisson post-2016 estimate is 0.45 (0.24–0.85; Pearson dispersion 1.67). These calculations describe the compilation. They do not establish a decline in true infringement incidence, an improvement in compliance or an effect of the pacer amendment.

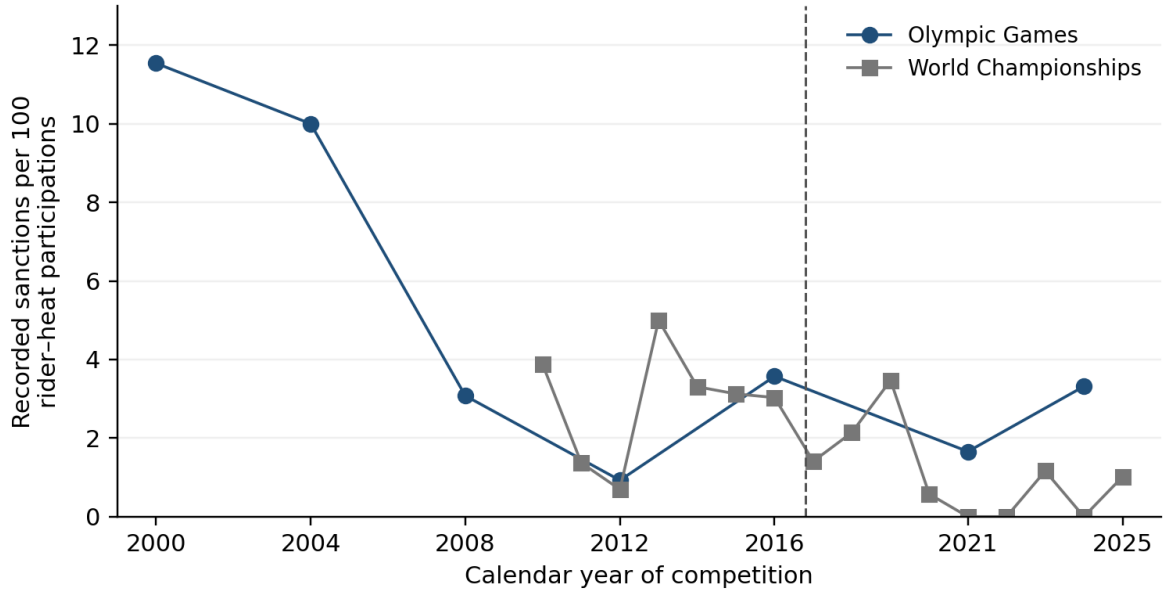


Figure 2 Recorded sanction rates by calendar year
Note. Each point combines both sexes where present in one edition. Tokyo 2020 is plotted at 2021. The dashed line marks October 2016. Rates use distinct rider–heat participations and exclude repeated attempts; the series is a source-dependent description, not an amendment-effect estimate.

The interpretation depends on temporal specification (Table 4). In the full series, Poisson AIC is 150.7 for a step, 146.3 for a calendar-year trend and 148.2 for both. In the combined quasi-Poisson model, the step estimate is 0.86 (0.33–2.26) and the annual trend estimate is 0.936 (0.869–1.008). Restricting the analysis to 2010–2025 gives AIC values of 134.1, 134.9 and 136.0; these do not clearly distinguish a step from a trend. In that restricted combined model, the step is 0.58 (0.14–2.40) and the annual trend is 0.983 (0.844–1.144). A trend-only estimate and a trend conditional on a step are different quantities and are reported separately. The exact 2010–2025 rate ratio is 0.50 (0.28–0.87), and the relegation-only ratio across the full period is 0.48 (0.27–0.84). None resolves changes in reporting or other contemporaneous factors.

Table 4
Exploratory rate and model comparisons

Comparison	**Ratio or IRR (95% CI)**	**p**
All events	0.40 (0.24–0.67)	<0.001
Olympic Games	0.53 (0.21–1.21)	0.150
World Championships	0.39 (0.19–0.75)	0.004
2010 onward	0.50 (0.28–0.87)	0.013
Relegations only	0.48 (0.27–0.84)	0.009
Adjusted step, full series	0.45 (0.24–0.85)	0.014
Step with trend, full series	0.86 (0.33–2.26)	0.762
Annual trend with step, full series	0.936 (0.869–1.008)	0.080

Comparison	Ratio or IRR (95% CI)	p
Annual trend without step, full series	0.928 (0.886–0.972)	0.002
Step with trend, 2010–2025	0.58 (0.14–2.40)	0.454
Annual trend with step, 2010–2025	0.983 (0.844–1.144)	0.823
Annual trend without step, 2010–2025	0.934 (0.870–1.001)	0.054
Poisson AIC, full series	150.7 / 146.3 / 148.2	—
Poisson AIC, 2010–2025	134.1 / 134.9 / 136.0	—

Note. IRR = incidence rate ratio; CI = confidence interval; AIC = Akaike information criterion. First five rows are exact conditional rate ratios (post/pre); subsequent parameter estimates use quasi-Poisson standard errors, adjusted for competition and sex. AIC order is step only / trend only / both, from Poisson likelihoods. Calendar year places Tokyo at 2021. Models are exploratory; within-edition dependence and source uncertainty are not fully represented. No causal inference is intended.

Distribution across nations

Japan accounts for 11 recorded sanctions; France, Great Britain, Malaysia, New Zealand and Russia for six each; China for five; and the Czech Republic for four. These are counts, not national rates, because national exposure and comparable incident opportunities were not compiled for a bias analysis. Sanctions imposed on British riders do not disprove preferential treatment, just as sanctions imposed on Malaysian riders do not establish adverse treatment. The national distribution is contextual description and is not used to rank explanations of the Paris decisions.

Case analyses

Table 5 compares the contested decisions.

Table 5

What the Olympic cases establish

Case	Recorded or reported outcome	Unresolved evidence	Bounded interpretation
Rio 2016 Keirin final	Two reported stoppages and restarts with all six riders; Kenny gold, Awang bronze.	Dedicated-view and team-video details come from published accounts; full jury reasoning unavailable.	Uncertainty about a triggering fact does not convert a fixed rule into a standard.
Tokyo 2020 Final held in 2021	Kenny's attack after departure produced a winning gap; Awang silver.	Rule knowledge and preparation were not measured.	Tactical illustration, not evidence that regulatory literacy caused victory.
Paris 2024 Awang	Official DQ for incorrect behaviour behind derny. Media describe passing the pacer.	Official result does not identify art. 3.2.140 or 3.2.142.	Mandatory consequence under 3.2.140; graded consequence under 3.2.142. Actual legal basis unresolved.
Paris 2024 Carlin	Existing quarterfinal warning; reported collision, restart and further warning; bronze retained. Later lane objection also reported.	Whether the additional warning was formal; separate reasoning for collision and later lane movement.	Second formal warning would engage written accumulation rule. Informal admonition would not establish that threshold.

Note. Sources: Paris 2024 (2024), Olympedia (n.d.), Cyclingnews (2016a), Windsor (2016), and the attributed Paris reports cited in the text. The table does not determine whether any decision was biased.

Rio 2016 and uncertainty about the triggering facts

Contemporary reports describe two stoppages in the Rio final after apparent early passing of the derny, followed by restarts with all six riders. Fault was attributed to the pacer (Cyclingnews, 2016a). Olympedia's account describes the absence of a dedicated official camera view and the use of footage from a British team analyst after the first stoppage; these are reported process details, not independently reconstructed findings here. Kenny described the rule as vague (Windsor, 2016). The same restarts allowed both Kenny and Awang to continue, but that common benefit cannot test neutrality. The case illustrates uncertainty about whether the facts required by a mandatory rule had been established. It does not demonstrate that officials were legally free to waive an established infringement or that the rule had become a standard. Reliance on team-supplied evidence also raises a separate question about equal access to relevant footage. The subsequent amendment improved specification of the reference point without eliminating the need for reliable evidence.

Tokyo 2020 and the tactical boundary

Tokyo's final, held in 2021, provides a tactical contrast. Kenny attacked as the pacer departed and opened a gap that the other riders did not close (Olympedia, n.d.). The race illustrates the transition from the paced phase to open racing. It does not establish that superior knowledge of the regulation caused the winning move, because riders' rule knowledge, anticipation and preparation were not measured.

Paris 2024 and conditional interpretations

The official first-round result confirms that Awang was disqualified for incorrect behaviour behind the derny but does not identify the article applied (Paris 2024, 2024, men's keirin first-round results, PDF pp. 94–95). Contemporary accounts describe overtaking the pacer. Beasley reportedly accepted a mistake while also describing an unexpectedly slow pacer; Awang described pressure from Helal and difficulty slowing down (Bernama, 2024; Malay Mail, 2024a, 2024b; NBC Olympics, 2024). These accounts are not an independent reconstruction of speed, position or causation. If the factual trigger in art. 3.2.140 was established and that article was applied, disqualification was mandatory and a warning was not its alternative sanction. If art. 3.2.142 was applied, the text allowed a gravity-dependent penalty. The official result label alone does not decide between those possibilities. Accordingly, the sanction is counted as a DQ, while its article remains unresolved; no confirmed pacer-specific incidence rate is estimated.

Carlin's sprint case involves two reported incidents that should be separated. Weislo (2024) describes a low-speed collision before the deciding bronze-medal race, a stoppage and restart, and an additional warning. The same report describes Kordi's objection to a lane departure during the restarted race; the account that the movement did not affect the race concerns that later objection. Carlin already carried a quarterfinal warning. The official sprint final classification shows a warning marker and his bronze-medal result, but does not establish a second formal warning (Paris 2024, 2024, PDF p. 60). A press report's use of warning could denote a formal sanction or an informal admonition; its status cannot be

settled from that wording. The analysis therefore does not treat two formal warnings as an established fact or combine the explanations of the two incidents.

The comparison has two independent uncertainties. For Awang, the applied article determines whether the sanction was fixed or graded. For Carlin, the formal status of the reported additional warning determines whether the written accumulation rule was engaged. If Carlin received a second formal warning under the applicable 2023 text, continued participation would require reconciliation with art. 3.10.003; discretionary evaluation of riding does not itself erase that consequence. If the additional communication was informal, the accumulation threshold may not have been reached. Likewise, the contrast between mandatory and discretionary sanctions is plausible only under the art. 3.2.140 interpretation of Awang's case. Neither scenario establishes the actual reasoning of the officials or excludes nationality bias. The defensible finding is the need for an identifiable article, a formal sanction record and sufficiently specific reasons.

Discussion

Textual precision and evidential reliability

The 2016 pacer amendment changed the triggering geometry and specified a track reference while retaining disqualification. This is a clearer example of increased specification than of increased severity. Yet textual precision, evidential reliability and sanction discretion remain distinct. A fixed threshold can be hard to observe; a clear video can establish conduct that still requires evaluative classification; and a graded penalty can follow a well-established breach. The Rio account illustrates the evidential problem. It does not justify describing a mandatory rule as a standard merely because officials had to decide what happened. The practical value of a clearer boundary depends partly on the recording system that can establish whether it was crossed (Collins et al., 2016; Diver, 1983).

A fixed consequence may capture conduct that differs in intention or practical harm, the familiar concern of over-inclusiveness in rule design (Schauer, 1991; Sunstein, 1995). Applied conditionally to Awang, this explains why contextual mitigation might not alter a sanction under art. 3.2.140. It does not establish that the UCI consciously accepted a particular policy trade-off, or that all asserted circumstances occurred. The separate 2020 amendment to art. 3.2.142 demonstrates that sanction structure can change independently of the pacer-passing threshold. The theoretical contribution is therefore to examine each provision's trigger, evidentiary demands and consequence separately.

What the sanction record can establish

The reconstructed record permits transparent recalculation of reported sanction rates and exposes errors hidden by aggregate totals. It is stronger than an unexplained total of races and starts, but remains dependent on the underlying results pages. Reasons are often absent, historical DQ labels are not uniform and warnings are incompletely recorded. Awang is the case in this compilation whose media accounts specifically support a pacer-pass interpretation; this cannot establish that he was the only rider to breach that article during the observation window. Nor does a low number of identified pacer cases demonstrate good rule knowledge or inadequate rehearsal of rare events. The lower post-2016 recorded rate is a descriptive association that could reflect compliance, enforcement, reporting or the composition of events. Distinguishing those explanations requires additional evidence.

Consistency, explanation and perceived bias

The contrast between an early elimination and a medal won after a disputed incident understandably invites scrutiny. However, a rules-based interpretation and a bias explanation answer different questions and may coexist. This study supplies no matched counterfactual incidents, no national exposure model and no direct measure of officials' preferences. A coach's acceptance of an outcome, British riders' other sanctions and Awang's benefit from Rio restarts do not resolve those missing comparisons. The claim supported here is narrower: differences in the provisions applied could contribute to different outcomes, conditional on facts about the article and formal warnings that remain uncertain.

Procedural and informational justice help explain why the accessibility of reasons matters (Colquitt, 2001; Lind & Tyler, 1988; Tyler, 2006a). In the sources examined, a publicly accessible decision identifying Awang's article and resolving the status of Carlin's reported additional warning was not located. This is a limit of the retrieved record, not proof that officials supplied no explanation through any channel. A concise statement of the article, evidence considered, formal sanction and relevant warning history would make the comparison more assessable. The field-of-play tradition discussed by Duval (2013) and Foster (2003) adds practical importance to clear records within the sporting process, without making every disputed outcome unlawful or biased.

Regulatory preparedness as a performance skill

Table 6 proposes a regulatory-preparedness framework for national programmes. Rule literacy should cover the text applicable at the competition date, including the pacer threshold, graded conduct penalties and formal warning accumulation. Scenario rehearsal can place these requirements in representative training situations (Pinder, Davids, Renshaw, & Araújo, 2011), such as changing pace or adjacent-rider pressure. Pressure-related performance difficulties provide a rationale for rehearsal (Hill, Hanton, Matthews, & Fleming, 2010), but this study does not show that any rider lacked knowledge or preparation. Training responses should be designed with qualified coaches for the demands of riding a fixed-gear track bicycle. The framework is a proposal, not a validated intervention.

Table 6
Proposed regulatory preparedness practices

Practice	Application	Rationale	Possible measure
Rule literacy	Teach the version applicable at the event, including formal warning accumulation.	Regulatory text and amendment dates differ.	Scenario-based knowledge assessment.
Scenario rehearsal	Coach safe responses to changing pacer speed, lateral pressure and positioning.	Cases identify plausible challenges; individual causes remain uncertain.	Observed choices in representative drills.
Video review	Review relative wheel position and pacer departure from useful angles.	A precise threshold still needs adequate evidence.	Consistency of positioning and interpretation.
Specialist support	Assign responsibility for rule updates and official communications.	Track provisions and procedures change.	Named specialist; dated update record.

Practice	Application	Rationale	Possible measure
Decision review readiness	Preserve evidence and check available review channels and deadlines.	Grounds and reviewability depend on the decision and rules.	A rehearsed evidence and communication protocol.
Institutional record	Maintain dated cases, separating official findings from disputed accounts.	Informal retellings can obscure articles and warning status.	Complete case files and periodic review.

Note. These are proposals derived from the analysis and training literature, not interventions shown to reduce infringements. Safety and drill design require qualified coaching.

Video review can help athletes and coaches examine positioning near the pacer's departure. A designated rules specialist can monitor amendments and the event's official communications. Teams can also prepare a process for obtaining decisions, preserving footage and checking which review channels and time limits actually apply; the existence of an appeal for every field-of-play decision should not be assumed. The usefulness of a challenge depends on the rule and evidence, so the Paris accounts do not justify declaring a protest inherently pointless. Finally, a dated case archive can distinguish confirmed sanctions from disputed interpretations and avoid carrying obsolete warning rules into future competitions.

For Malaysian programmes, the selected cases can support a practical review of preparation and communication. The six Malaysian sanctions in the record do not establish a national preparation deficit, because exposure and training practices were not evaluated. Learning from an adverse decision and examining its fairness are compatible activities. The proposed framework should be assessed prospectively with measures of knowledge, scenario performance and regulatory outcomes before claims of effectiveness are made.

Implications for governing bodies

For governing bodies, the priorities are evidentiary reliability and accessible decisions. Pacer telemetry and an appropriate camera view could improve the reconstruction of departures, without automatically changing the legal significance of a slow pacer. Published reasons should identify the article applied and distinguish the finding of an infringement from the choice of sanction. The warning system already has written accumulation and recording requirements; the practical recommendation is to make formal warnings, their carry-over and any consequent disqualification easy for teams and observers to follow. Article citations and dated rule versions would also prevent later amendments from being used to explain earlier decisions.

Limitations

The quantitative strand covers 43 selected-frame events and is exploratory. Complete enumeration of those event tables is not equivalent to complete ascertainment of infringements or sanctions. Counts are small, events within an edition may be dependent and the confidence intervals are conditional on modelling assumptions. A single amendment date, coincident format and technology changes, unequal observation windows and the absence of a suitable comparison series prevent a causal estimate of the 2016 amendment. The purposive cases were known before analysis and were selected for their relevance to Malaysian debate, not to represent all decisions.

The heat ledger removes ambiguity about the revised denominator, but most values are reconstructed from secondary sources. Only the Paris keirin events received a complete comparison with the official results book for this study; other checks are targeted and recorded. Missing status annotations required reconciliation with Olympedia, and legal reasons remain unavailable for many DQ-labelled outcomes. A rider–heat denominator excludes repeated attempts and does not measure actual start opportunities or time exposed to an infringement. Warnings alone are outside the quantitative outcome. Source and coding uncertainty are not included in the statistical intervals, and a comprehensive primary-source audit could change the estimates.

National counts cannot test bias without comparable incidents and relevant exposure. Participant and media accounts cannot substitute for the commissaires' full record. The public label in Awang's case leaves the article unresolved; the reported additional warning in Carlin's case leaves its formal status unresolved. Documentary coding was not independently duplicated. The historical comparison uses selected regulatory snapshots and their amendment annotations rather than every intervening edition or all competition-specific communications. The targeted literature check was non-systematic and does not support an exhaustive statement of novelty.

Further work should validate all heat and sanction entries against official reports, document restarts separately, obtain article-specific decisions and warning registers, and collect national exposure and comparable incident data. Interviews and video review could investigate how officials interpreted particular provisions. A prospective evaluation of regulatory preparedness would require predefined outcomes and direct observations of training and competition behaviour.

Conclusion

The keirin pacer amendment of 2016 made the triggering geometry more explicit while retaining mandatory disqualification. Evidential uncertainty must be distinguished from discretion to evaluate conduct or select a penalty. Warning accumulation was written into the rules before Paris 2024, so the Carlin comparison turns on whether the reported additional warning was formal, not on an absence of regulation. Awang's official result confirms disqualification but leaves the applied article unidentified. A mandatory-rule interpretation is therefore conditional. The reconstructed public-results record is auditable and yields lower recorded rates after 2016, but it neither identifies an amendment effect nor tests nationality bias. Clear article-specific decisions and accessible warning records would improve the basis for assessing consistency. National programmes can incorporate regulatory rehearsal and decision-record literacy into preparation, while the effectiveness of that approach remains to be tested. More broadly, the study shows how separating textual precision, evidence and sanction selection within an auditable record can clarify contested decisions in sport governance and in other settings where reasons are not routinely published.

Conflict of interest

The authors declare no conflict of interest.

Ethics and data availability

The study used publicly available regulations, competition results and media reports. It involved no direct participant recruitment, intervention or collection of private personal information. Named athletes, coaches and officials are discussed only in relation to publicly reported decisions and statements.

The accompanying supplementary package contains keirin_events_2000_2025.csv, keirin_heat_ledger.csv, keirin_rider_heat_ledger.csv and keirin_sanctions_2000_2025.csv; source and correction registers; keirin_analysis.py; and analysis_results.json. The script reproduces the revised descriptive and exploratory results and Figure 2. These files are a documented reconstruction, not an official dataset issued by the Union Cycliste Internationale or the International Olympic Committee. Verification levels and unresolved legal classifications are retained explicitly. Table 1 supplies event totals.

Relationship to other work

The Rio, Tokyo and Paris cases are also discussed in the first author's book manuscript in preparation. The present article develops the regulatory comparison and an accompanying event-level reconstruction.

AI-assisted editing

Generative AI tools, including ChatGPT (OpenAI), assisted with literature and source retrieval, data reconstruction, code preparation and checking, and language and structural revision. Computational checks and targeted source comparisons are distinguished from a full independent human audit. The authors are responsible for reviewing and approving the final data, interpretations and disclosures before submission.

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References

Altman, D. G., & Bland, J. M. (1995). Statistics notes: Absence of evidence is not evidence of absence. BMJ, 311(7003), 485. https://doi.org/10.1136/bmj.311.7003.485

Balmer, N. J., Nevill, A. M., & Williams, A. M. (2003). Modelling home advantage in the Summer Olympic Games. Journal of Sports Sciences, 21(6), 469–478. https://doi.org/10.1080/0264041031000101890

Bernama. (2024, August 11). Olympic Games: Azizulhasni has no intention of overtaking pacer. Retrieved from https://www.bernama.com/en/news.php?id=2327887

Bowen, G. A. (2009). Document analysis as a qualitative research method. Qualitative Research Journal, 9(2), 27–40. https://doi.org/10.3316/QRJ0902027

Collins, H., Evans, R., & Higgins, C. (2016). Bad call: Technology's attack on referees and umpires and how to fix it. Cambridge, MA: MIT Press.

Colquitt, J. A. (2001). On the dimensionality of organizational justice: A construct validation of a measure. Journal of Applied Psychology, 86(3), 386–400. https://doi.org/10.1037/0021-9010.86.3.386

Craig, N. P., & Norton, K. I. (2001). Characteristics of track cycling. Sports Medicine, 31(7), 457–468. https://doi.org/10.2165/00007256-200131070-00001

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). Thousand Oaks, CA: SAGE.

Cycling Weekly. (2016, October 13). Track events get major overhaul in new UCI rule change. Retrieved from https://www.cyclingweekly.com/news/racing/track-events-gets-major-overhaul-new-uci-rule-change-289919

Cyclingnews. (2016a, August 17). Olympic Games: Kenny celebrates sixth career gold medal in tense keirin final. Retrieved from https://www.cyclingnews.com/news/olympic-games-kenny-celebrates-sixth-career-gold-medal-in-tense-keirin-final/

Cyclingnews. (2016b, October 13). UCI makes sweeping changes to track cycling programme. Retrieved from https://www.cyclingnews.com/news/uci-makes-sweeping-changes-to-track-cycling-programme/

Diver, C. S. (1983). The optimal precision of administrative rules. Yale Law Journal, 93(1), 65–109. https://doi.org/10.2307/796245

Dohmen, T., & Sauermann, J. (2016). Referee bias. Journal of Economic Surveys, 30(4), 679–695. https://doi.org/10.1111/joes.12106

Duval, A. (2013). Lex sportiva: A playground for transnational law. European Law Journal, 19(6), 822–842. https://doi.org/10.1111/eulj.12067

Ehrlich, I., & Posner, R. A. (1974). An economic analysis of legal rulemaking. Journal of Legal Studies, 3(1), 257–286. https://doi.org/10.1086/467515

Emerson, J. W., Seltzer, M., & Lin, D. (2009). Assessing judging bias: An example from the 2000 Olympic Games. The American Statistician, 63(2), 124–131. https://doi.org/10.1198/tast.2009.0026

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. Qualitative Inquiry, 12(2), 219–245. https://doi.org/10.1177/1077800405284363

Foster, K. (2003). Is there a global sports law? Entertainment and Sports Law Journal, 2(1), 1. https://doi.org/10.16997/eslj.146

Furukawa, T. (1997). Processes of change in professional bicycle racing (keirin): The relationship between sports and gambling [in Japanese with English abstract]. Japan Journal of Sport Sociology, 6, 84–96. https://doi.org/10.5987/jjsss.6.84

Garwood, F. (1936). Fiducial limits for the Poisson distribution. Biometrika, 28(3–4), 437–442. https://doi.org/10.1093/biomet/28.3-4.437

Gu, K., Ng, H. K. T., Tang, M. L., & Schucany, W. R. (2008). Testing the ratio of two Poisson rates. Biometrical Journal, 50(2), 283–298. https://doi.org/10.1002/bimj.200710403

Hancock, D. J., Bennett, S., Roaten, H., Chapman, K., & Stanley, C. (2021). An analysis of literature on sport officiating research. Research Quarterly for Exercise and Sport, 92(4), 607–617. https://doi.org/10.1080/02701367.2020.1756198

Heiniger, S., & Mercier, H. (2021). Judging the judges: Evaluating the accuracy and national bias of international gymnastics judges. Journal of Quantitative Analysis in Sports, 17(4), 289–305. https://doi.org/10.1515/jqas-2019-0113

Hill, D. M., Hanton, S., Matthews, N., & Fleming, S. (2010). Choking in sport: A review. International Review of Sport and Exercise Psychology, 3(1), 24–39. https://doi.org/10.1080/17509840903301199

Kaplow, L. (1992). Rules versus standards: An economic analysis. Duke Law Journal, 42(3), 557–629. https://doi.org/10.2307/1372840

Kendall, G., & Lenten, L. J. A. (2017). When sports rules go awry. European Journal of Operational Research, 257(2), 377–394. https://doi.org/10.1016/j.ejor.2016.06.050

Kolbinger, O., & Lames, M. (2017). Scientific approaches to technological officiating aids in game sports. Current Issues in Sport Science, 2, 001. https://doi.org/10.15203/CISS_2017.001

Lind, E. A., & Tyler, T. R. (1988). The social psychology of procedural justice. New York, NY: Plenum Press. https://doi.org/10.1007/978-1-4899-2115-4

Lindsay, A., Petersen, C., Blackwell, G., Ferguson, H., Parker, G., Steyn, N., & Gieseg, S. P. (2017). The effect of 1 week of repeated ischaemic leg preconditioning on simulated Keirin cycling performance: A randomised trial. BMJ Open Sport & Exercise Medicine, 3(1), e000229. https://doi.org/10.1136/bmjsem-2017-000229

Lopez Bernal, J., Cummins, S., & Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: A tutorial. International Journal of Epidemiology, 46(1), 348–355. https://doi.org/10.1093/ije/dyw098

MacMahon, C., Mascarenhas, D., Plessner, H., Pizzera, A., Oudejans, R., & Raab, M. (2015). Sports officials and officiating: Science and practice. London, England: Routledge. https://doi.org/10.4324/9780203700525

Malay Mail. (2024a, August 11). Early exit for “Pocket Rocketman” after Azizulhasni disqualified in Olympic men’s keirin first round. Retrieved from https://www.malaymail.com/news/sports/2024/08/11/early-exit-for-pocket-rocketman-after-azizulhasni-disqualified-in-olympic-mens-keirin-first-round/146629

Malay Mail. (2024b, August 11). What is a derny anyway? Here’s why Pocket Rocketman Azizulhasni’s Olympic dream was dashed after keirin disqualification. Retrieved from https://www.malaymail.com/news/sports/2024/08/11/what-is-a-derny-anyway-heres-why-pocket-rocketman-azizulhasnis-olympic-dream-was-dashed-after-keirin-disqualification/146657

Malay Mail. (2024c, August 11). Tengku Zafrul questions lack of action against French rider in Azizulhasni’s disqualification from Paris Olympics. Retrieved from https://www.malaymail.com/news/malaysia/2024/08/11/tengku-zafrul-questions-lack-of-action-against-french-rider-in-azizulhasnis-disqualification-from-paris-olympics/146697

Mascarenhas, D. R. D., Collins, D., & Mortimer, P. (2005). Elite refereeing performance: Developing a model for sport science support. The Sport Psychologist, 19(4), 364–379. https://doi.org/10.1123/tsp.19.4.364

Moffatt, J., Scarf, P., Passfield, L., McHale, I. G., & Zhang, K. (2014). To lead or not to lead: Analysis of the sprint in track cycling. Journal of Quantitative Analysis in Sports, 10(2), 161–172. https://doi.org/10.1515/jqas-2013-0112

NBC Olympics. (2024). A sad ending for Malaysia’s Azizulhasni Awang in men’s keirin disqualification. Retrieved from https://www.nbcolympics.com/news/sad-ending-malaysias-azizulhasni-awang-mens-keirin-disqualification

Olympedia. (n.d.). Keirin event results and annotations [Database]. Sydney 2000 men: https://www.olympedia.org/results/154983; London 2012 men: https://www.olympedia.org/results/308096; Rio 2016 men: https://www.olympedia.org/results/356781; Tokyo 2020 men: https://www.olympedia.org/results/19004957. Retrieved 20 October 2026 for the targeted checks; source-specific verification is documented in the supplementary register.

Paris 2024. (2024). Cycling track results book. Men’s keirin: PDF pp. 85–95; women’s keirin: pp. 173–182; men’s sprint final classification: p. 60. Retrieved from

https://assets.ctfassets.net/761l7gh5x5an/7BbspOVZFQv5kTUePoX2om/26e8090163553edf4d547aecbfd08c54/2024-Cycling_Track.pdf

Pettersson-Lidbom, P., & Priks, M. (2010). Behavior under social pressure: Empty Italian stadiums and referee bias. Economics Letters, 108(2), 212–214. https://doi.org/10.1016/j.econlet.2010.04.023

Pinder, R. A., Davids, K., Renshaw, I., & Araújo, D. (2011). Representative learning design and functionality of research and practice in sport. Journal of Sport and Exercise Psychology, 33(1), 146–155. https://doi.org/10.1123/jsep.33.1.146

Plessner, H., & Haar, T. (2006). Sports performance judgments from a social cognitive perspective. Psychology of Sport and Exercise, 7(6), 555–575. https://doi.org/10.1016/j.psychsport.2006.03.007

Russell, J. S. (1999). Are rules all an umpire has to work with? Journal of the Philosophy of Sport, 26(1), 27–49. https://doi.org/10.1080/00948705.1999.9714577

Rysman, J.-F., Cohen, C., Sachet, I., Brunet, E., Baré, A., Baugé, G., . . . Clanet, C. (2025). Routes to victory in track cycling sprint. International Journal of Performance Analysis in Sport, 25(6), 1100–1114. https://doi.org/10.1080/24748668.2025.2491999

Sandve, G. K., Nekrutenko, A., Taylor, J., & Hovig, E. (2013). Ten simple rules for reproducible computational research. PLOS Computational Biology, 9(10), e1003285. https://doi.org/10.1371/journal.pcbi.1003285

Schauer, F. (1991). Playing by the rules: A philosophical examination of rule-based decision-making in law and in life. Oxford, England: Clarendon Press. https://doi.org/10.1093/acprof:oso/9780198258315.001.0001

Sunstein, C. R. (1995). Problems with rules. California Law Review, 83(4), 953–1026. https://doi.org/10.2307/3480896

Tyler, T. R. (2006a). Psychological perspectives on legitimacy and legitimation. Annual Review of Psychology, 57, 375–400. https://doi.org/10.1146/annurev.psych.57.102904.190038

Tyler, T. R. (2006b). Why people obey the law. Princeton, NJ: Princeton University Press. https://doi.org/10.1515/9781400828609

Union Cycliste Internationale. (2014). UCI cycling regulations: Part 3 – Track races (March 2014 version) [Archived copy]. Retrieved from https://wpcycling.com/wp-content/uploads/2015/09/UCI-Track-Regulations-English.pdf

Union Cycliste Internationale. (2016, October 13). UCI Management Committee agrees key changes to the regulations of three cycling disciplines. Retrieved from https://www.uci.org/pressrelease/uci-management-committee-agrees-key-changes-to-the-regulations-of-three/69b89n2PxtSIq7OTSLNJb4

Union Cycliste Internationale. (2020). Track – penalties list [Working tool]. Retrieved from https://assets.usacycling.org/prod/assets/UCI-Track-Penalties.pdf

Union Cycliste Internationale. (2023). UCI cycling regulations: Part 3 – Track races (version of 1 August 2023). Retrieved from https://assets.ctfassets.net/761l7gh5x5an/6jGCKQEr7a5NTvzdo1mzzI/518ba50be2382fbb6777dfe183c48c53/3-PIS-20230801-E_-_Regulations_update_2023.pdf

Union Cycliste Internationale. (2026). UCI cycling regulations: Part 3 – Track races (version of 1 January 2026). Retrieved from https://assets.ctfassets.net/761l7gh5x5an/7IE4WjTvQLqeRF5aniDP34/6a48689b99f3ac31c190fb46513ca56f/PART_3_E_-_As_of_01.01.2026.pdf

Ver Hoef, J. M., & Boveng, P. L. (2007). Quasi-Poisson vs. negative binomial regression: How should we model overdispersed count data? Ecology, 88(11), 2766–2772. https://doi.org/10.1890/07-0043.1

Virtanen, P., Gommers, R., Oliphant, T. E., Haberland, M., Reddy, T., Cournapeau, D., . . . van Mulbregt, P. (2020). SciPy 1.0: Fundamental algorithms for scientific computing in Python. Nature Methods, 17, 261–272. https://doi.org/10.1038/s41592-019-0686-2

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & STROBE Initiative. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. PLOS Medicine, 4(10), e296. https://doi.org/10.1371/journal.pmed.0040296

Wagner, A. K., Soumerai, S. B., Zhang, F., & Ross-Degnan, D. (2002). Segmented regression analysis of interrupted time series studies in medication use research. Journal of Clinical Pharmacy and Therapeutics, 27(4), 299–309. https://doi.org/10.1046/j.1365-2710.2002.00430.x

Wasserstein, R. L., & Lazar, N. A. (2016). The ASA statement on p-values: Context, process, and purpose. The American Statistician, 70(2), 129–133. https://doi.org/10.1080/00031305.2016.1154108

Weislo, L. (2024, August 9). Paris Olympics: Dutch team baffled by officials not calling Jack Carlin on “rugby on wheels”. Cyclingnews. Retrieved from https://www.cyclingnews.com/news/paris-olympics-dutch-team-baffled-by-officials-not-calling-jack-carlin-on-rugby-on-wheels/

Wikipedia contributors. (2026). Olympic and UCI Track Cycling World Championship keirin results [43 event-specific pages]. Retrieved 20 October 2026. Exact event URLs, revision identifiers and file hashes are provided in supplementary source_register.csv; the associated rider–heat ledger identifies each table and row.

Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., . . . Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data, 3, 160018. https://doi.org/10.1038/sdata.2016.18

Windsor, R. (2016, August 17). Jason Kenny: I thought the keirin official was a bit trigger happy. Cycling Weekly. Retrieved from https://www.cyclingweekly.com/news/racing/olympics/jason-kenny-thought-keirin-official-bit-trigger-happy-275545

Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). Thousand Oaks, CA: SAGE.

Zitzewitz, E. (2006). Nationalism in winter sports judging and its lessons for organizational decision making. Journal of Economics & Management Strategy, 15(1), 67–99. https://doi.org/10.1111/j.1530-9134.2006.00092.x