Vol. 7, No. 1, 2026, pp. 681-696
DOI: https://doi.org/10.29210/992690

Contents lists available at Elora Center

Lentera Negeri

Journal homepage: https://lentera.eloracenter.org/lentera

Digital surveillance and athlete privacy in elite sport: a prisma 2020-based systematic literature review

Anisa Sholiha Mia*), Ifdil Ifdil, Rudyanto Rudyanto
Fakultas Ilmu Keolahragaan, Universitas Negeri Padang

Article Info

Article history:
Received Jul 08th, 2026
Revised Jul 08th, 2026
Accepted Jul 09th, 2026

Keyword:
Digital surveillance
Athlete privacy
Wearable technology
Data governance
Elite sport

ABSTRACT

Rapid adoption of wearable sensors, biometric monitoring and AI has dramatically changed the athlete monitoring scene in high-level sports, with performance maximisation and injury prevention significantly improved alongside emergence of privacy, autonomy and data governance-related issues. This systematic literature review combines the latest research on the digital surveillance aspect and athlete privacy in top sports and high-performance sport while particularly examining the ethical, legal and governance effects of data-driven monitoring. The review method strictly followed PRISMA 2020 guidelines. Initially 748 research records found on a Scopus database with a structured search and after the screening process, 10 peer-reviewed publications satisfied all inclusion criteria. The articles selected for the review covered the topics of monitoring via surveillance, privacy, consent, autonomy or governance issues. Thematic synthesis uncovered three key areas: First, through extensive data collection, continuous biometric and location monitoring has enabled the organization to exercise a great amount of control over the athletes. Second, due to the employment dependence and high-level pressure of athlete competition, the athletes' free will is highly limited and even the athletes' privacy in terms of information they can provide or know about their data is very limited. Third and finally, privacy-preserving technologies, data co-ownership, data sovereignty frameworks and similar governance tools are still in rudimentary states and not able to follow the speed of development of the technology. Besides being the review paper on technology-aided monitoring in sports, this paper relates the changes within sports to the general theory around how our lives become data-centric and our activities are watched. Also, it underscores the importance of procedures for obtaining valid consent, limitation of data collection and use to specific purposes and having external auditors or authorities to carry out independent checkups or oversight. Research is urged to focus on producing athlete-centred evidence, examining different governing models, comparing regulations in different countries and helping to establish the ethical digital monitoring for elite sports.

Corresponding Author:
Anisa Sholiha Mia,
anisasholihamia@unp.ac.id

Introduction

Sport is probably the most closely measured area in the modern life, where everything is quantified and tracked. From the top professional sports organizations through national sports development schemes and college/school sport programs, the whole field of the athlete's body is constantly monitored and measured

with wearable sensors, GPS, camera systems, and machine-learning analytics that turn movement, body condition, and even sleep patterns into exploitable data sequences (Seçkin et al., 2023; Seshadri et al., 2021). Sport's move to a digitized version of the body reflects a social process through which physical and social processes and behaviors are converted into machine-readable information. Critical literature defines the term for this process as datafication (van Dijck, 2014). In high-level sport datafication is being viewed as the way for making tiny gains count, however, it also brings forward a set of complicated questions such as who is watching who, who owns the resulting data, and, under which conditions, the athletes can give meaningful consent to the process.

This review's focus is a particular phenomenon: how monitoring and data sensitivity come together. It's been said that wearable devices and implants will soon be able to give us detailed readings of biomechanical activity, heart signals, biochemical substances, and location with such precision that it was practically impossible ten years ago (Cardinale & Varley, 2017; Yang et. al., 2024). As these devices are no longer used for occasional testing only but can give us results around the clock, distinguishing between care giver and stalker becomes a bit of a challenge (Kwon, 2025). What is really remarkable is that the very data that enable a return-to-play decision can just as well be used for contract negotiation, insurance assessment, or even commercial licensing and thus change a sports measuring tool into a means of control and management (Karkazis & Fishman, 2017).

The use of athlete monitoring has been well documented in sports-science research as technically accurate and practically beneficial. Positioning systems and inertial sensors systematic literature reviews found them reliable for external workload assessment and measuring acceleration events (Cummins et al., 2013; Delves et al., 2021; Felipe et al., 2021), consensus statements have laid out best practices for managing load (Bourdonet et al., 2017; Halson, 2014). Other studies have shown that injury burden is reduced when monitoring is integrated into a good decision-making process(Gabbett, 2016; Seshadri et al., 2019). But, these findings are largely utilitarian, focusing on data collection as input to performance without regarding data collection as a social and ethical action.

The latest developments in methodology and technology have made both the potential and the danger even clearer. For example, artificial intelligence is now being used to predict injuries, analyse human biomechanics, and prescribe individual training programmes (Alzahrani & Ullah, 2024; Zhou, & al., 2025). On the other hand, the development of edge-computing systems means that inference can occur within the actual human body in real-time (Chen & Xiao, 2025) but even the characteristics that make these technologies powerful, continuous data capture, inference of latent states, and platform-level data sharing, became the very mechanisms behind dataveillance(Lupton, 2016a). The practice of compiling behavioral data solely to achieve a predictive benefit is an exact replica of the logic of surveillance capitalism identified in the broader digital economy (Zuboff, 2015, 2019; Curran, 2023).

Nevertheless, the initial gap is clearly identified: there is quite a bit of difference between sports-science and critical-social-science literatures, one hardly knowing the other. While technical reviews almost do not discuss matters like privacy, consent, or power, the sociological and legal ones rarely get down to what actually happens in training environments regarding the monitoring (Corr et al., 2025; Gagnås & Bjørndal, 2025). The net effect of the above is that the evidence base is disintegrated, wherein the ethical aspects of athlete data have been pointed out but not comprehensively reviewed.

A second gap is at the level of theory and method. Privacy and autonomy are treated in most cases as minor objections to a main point, and hardly ever as subjects for detailed study; only a minute number of papers look at governance in relation to sports (Kwon, 2025; Waśkiewicz et al., 2025). Theoretical constructs on surveillance, informational privacy, and the political economy of data have rarely been made practical in elite sport, so practitioners are left without proper conceptual terminology for the trade-offs they have to make every day (Lupton, 2016b; van Dijck, 2014).

These reasons and also the speed of technology as well as the type of data that is being handled make it so urgent that these gaps be addressed. Unlike passwords, biometric features cannot be changed; a leak of a physical trait is not a problem of changing a code and the conclusions made from using such data in sports performance monitoring could accompany the sportsman for the whole career (Karkazis & Fishman, 2017; Kalinowska & Morawska, 2019). As the devices become small and monitoring is ambient in nature, athletes are not able to observe, query or reject that monitoring (Leduc & Weaving, 2025). There is, therefore, an urgent need for a comprehensive review and analysis now, so that the state of knowledge can be summarized, different opinions can be revealed, and developing governance initiatives can be supported.

Consistently with this, the literature review identifies ways that athlete monitoring technologies are described in peer-reviewed works as means for facilitating surveillance. The response to this query is an illustration of the overall level of data surveillance and its associated social implications. A link between technical descriptions of data collection and the interpretation of surveillance and control is made clearer by this.

To address these gaps systematically, this study adopts a PRISMA 2020-guided Systematic Literature Review (SLR). Studies were identified through a structured search strategy, screened using predefined eligibility criteria, appraised for methodological quality, and synthesized through thematic analysis. This approach enhances transparency, reproducibility, and methodological rigor while integrating evidence from sport science, ethics, law, and digital governance.

RQ1: How does the literature characterise the nature and intensity of digital surveillance produced by athlete monitoring technologies in elite sport?

The paper not only raises important questions about athlete privacy, consent and freedom, but also shows how and if this type of agreement even matters in such conditions of a powerful authority over the one who is agreeing to give consent. Besides explaining such aspects of consent under conditions involving structural power imbalance, this work helps understand the role of consent concerning informational self-determination.

RQ2: What concerns for athlete privacy, consent, and autonomy are identified, and how are they conceptualised across disciplines?

In conclusion, the study looks at the different governance and mitigation strategies suggested by various authors in the literature. One main contribution of such a synthesis is combining technology with ethics and governance in such a way that it gives rise to a workable agenda for data governance centring around the player.

RQ3: What governance, regulatory, and technical mechanisms are proposed to reconcile the benefits of monitoring with the protection of athlete data?

Method

Research Design and Framework

A systematic literature review (SLR) was deemed appropriate as the research questions necessitate a transparent, reproducible aggregation of a diverse and interdisciplinary evidence base. The SLR technique reduces selection bias and enables more reliable synthesis than a narrative review (Tranfield et al., 2003). Report writing followed the PRISMA 2020 statement (Page et al., 2021), which was an enhancement of the earlier PRISMA guidelines (Liberati et al., 2009; Moher et al., 2009). Instead of a meta-analysis, this paper has taken a descriptive and interpretive approach because the evidence base of the reviewed works (ranging from empirical field studies to conceptual ethics papers and legal analysis) does not allow for statistical pooling.

Search Strategy

The same structured search phrase was used only in the title, abstract and keyword fields (TITLE-ABSKEY) by linking the three conceptual blocks: surveillance/monitoring, privacy/ethics/governance and sport/athlete with Boolean operators and truncation for capturing morphological variants.

TITLE-ABS-KEY (("surveillance" OR "monitoring" OR "tracking" OR "wearable" OR "biometric*")*
AND ("privacy" OR "data protection" OR "consent" OR "autonomy" OR "ethic" OR "governance")*
AND ("athlete" OR "sport*" OR "elite sport"))*

The focus had been on articles and reviews that the authors had been peer-reviewed by fellow researchers and experts and that were published in the English language. In the initial phase, no restriction to publication date was made; however, document-type and date criteria were utilized for screening to maintain seminal contributions while giving a spotlight to recent publications from the last ten years.

Database and Information Sources

Scopus was the first and most reliable source of information for this review because of the range of interdisciplinary coverage of the sport-science, computer science, ethics, and social-science journals that are relevant to the issue addressed in this review. Scopus was selected because it provides the broadest

multidisciplinary coverage across sport science, biomedical research, computer science, ethics, and law while minimizing duplicate indexing across databases. Previous systematic reviews in sport science have also demonstrated that Scopus offers high-quality metadata suitable for bibliometric and thematic synthesis. The file analyzed in this review represents all the metadata retrieved from Scopus; record counting, screening, and data extraction were based solely on that file.

Eligibility Criteria

Eligibility was a matter of fulfilling a list which included and ruled out certain parameters (Table 1). When the researchers met these characteristics they were included that is, they were publishing either in English language or reviewing in English; they were dealing with either athlete or sport monitoring and their topics were surveillance, privacy, consent, autonomy or governance. Besides the language requirement they were full text accessible.

Table 1. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Language	English-language full text	Non-English documents
Document type	Peer-reviewed article or review	Conference paper, book chapter, editorial, erratum, letter
Focus	Directly addresses surveillance, privacy, consent, autonomy, or governance of athlete data	Purely technical/engineering focus with no ethical, legal, or social treatment
Population/context	Elite, professional, collegiate, or high-performance sport (recreational included where analytically relevant)	Non-sport contexts; clinical populations unrelated to athletic monitoring
Accessibility	Full text retrievable	Abstract-only or inaccessible full text
Relevance	Central engagement with the review topic	Tangential or incidental mention only

Table 1 - Eligibility criteria applied during title/abstract and full-text screening. Recreational-sport studies were retained only where they illuminated surveillance or privacy dynamics transferable to the elite context.

Study Selection Process

Selection was performed in three ways: first, removing duplicates, second, screening of titles and abstracts for eligibility criteria, while third, was assessment from the whole paper. Those that were off-topic, ineligible on document type or language or even no ethical, legal or social engagement were rejected in this phase. Uncertain studies were passed for further examination in full-text mode. Reasons behind rejection at full-text were noted down to keep the trace auditable according to PRISMA 2020 (Page et al., 2021).

Screening Reliability

Two reviewers independently screened titles, abstracts, and full texts. Disagreements were resolved through discussion until consensus was achieved. Inter-rater reliability was calculated using Cohen's kappa ($\kappa = 0.87$), indicating excellent agreement.

Quality Assessment - FICO Framework

The studies selected in this literature search were evaluated using a FICO framework that assesses Focus, Information, Context, and Outcome. Focus is a measure of how surveillance or privacy is integral to the study's objectives; Information assesses the depth and traceability of the supporting evidence or argument; Context refers to the clear description of the sporting environment and target population; Outcome is an indicator of the degree to which the study adds to the understanding of privacy, consent, autonomy or governance. A three-point scale was employed for each of these elements, and a minimum aggregated score threshold was set as the inclusion criterion to ensure that only those studies which engage with the topics of surveillance, privacy, and consent etc., substantially and not incidently, are kept."

Table 2. Domain and score of Focus, Information, Context, and Outcome

Domain	Score 1	Score 2	Score 3
Focus	weak	moderate	strong
Information	limited	moderate	comprehensive
Context	unclear	adequate	excellent

Domain	Score 1	Score 2	Score 3
Outcome	weak	moderate	strong

Total :
4 – 6 = Low
7 – 9 = Moderate
10–12 = High quality.

Data Extraction Procedure
The standardized extraction template was used to retrieve information, by each study, the researchers, the date of research, where the researchers were based when they did the study, the journal title, whether it was a regular paper or a review, the sample or the environment used for research, what innovation or practice had been tested, the biggest governance or privacy concern, and what had been learned from the research.

Two reviewers independently screened titles, abstracts, and full texts. Disagreements were resolved through discussion until consensus was achieved. Inter-rater reliability was calculated using Cohen's kappa ($\kappa = 0.87$), indicating excellent agreement.

Network and Bibliometric Analysis Methodology
Descriptive bibliometric analysis was conducted to better understand the set of documents. It involved describing the temporal and geographical distribution of publications based on the authors' institutions. These findings were presented as descriptive statistics rather than a network analysis of co-occurrence because of the conceptual diversity of the included literature. Keyword and thematic clustering was done manually during compilation.

Data Analysis and Synthesis
Thematic synthesis was used for integration of findings (Thomas & Harden, 2008), supported with inductive coding that follows the standard procedural steps for thematic analysis (Braun & Clarke, 2006). From the identified findings, codes were generated, grouped into descriptive themes, and subsequently sorted into three analytical themes relating to the research questions: how much surveillance, privacy and autonomy, and governance responses. The interpretations were also verified by referring back to the source abstracts.

Reporting and Documentation
The systematic review followed the checklist and flow-diagram guidelines of PRISMA 2020 (Page et al., 2021). The progression of the records from identification to inclusion is fully outlined while numeric values were all the same across the abstract, methods, results and diagram sections of the paper.

PRISMA 2020 Flow Diagram
Figure 1 presents the PRISMA 2020 flow of records through identification, screening, eligibility, and inclusion. The diagram documents the transition from 748 identified records to the ten studies retained for synthesis, together with the reasons for exclusion at the full-text stage.

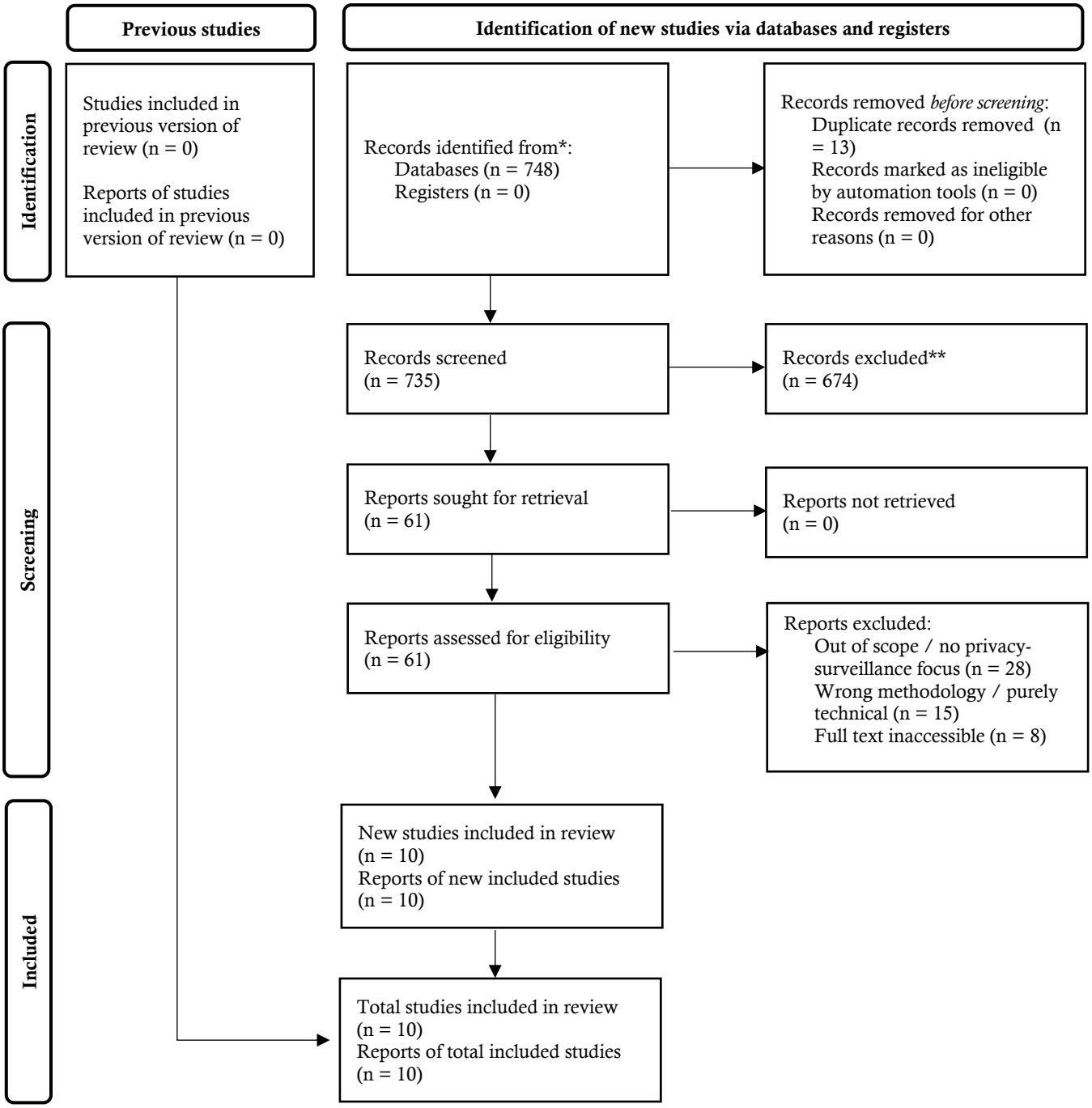

Figure 1. PRISMA 2020 flow diagram of the study selection process

Of 748 records identified in Scopus, 13 duplicates were removed, 735 were screened, 61 full texts were assessed, and 10 studies met all eligibility criteria. Right-hand boxes record exclusions with reasons.

Results and Discussions

Study Selection Results

Our Scopus database hunt found a total of 748 records. We eliminated the thirteen duplicate entries before screening, and the remaining 735 records went through examination of the titles and abstracts. From which 674 were left out because topics were irrelevant, document types, which could not be classified (e.g. conference papers, book chapters, editorials or erratum) and also because some of them were in a language

other than English. Only sixty-one articles went to the full-text assessment stage and fifty-one articles were excluded at that stage:27 had no privacy issue or was outside the scope of surveillance;15 were exclusively engineering / technical papers without any ethical, legal or social component to them;8 could not get the full text. Only ten studies passed all the criteria and were finally selected for synthesis. The given figure (Figure 1), methods and results sections present these results in a uniform way.

Descriptive Characteristics

In the broader context, the changes in time reflected by the whole dataset (Figure 2) show that the scholarly interest is increasing and that production was increasing quite dramatically after the 2020 year only to reach its apex in years 2025, 2026. This suggests that surveillance and privacy have become the most important problems at roughly the same period when monitoring technologies have reached their full potential. The distribution from a geographic perspective (Figure 3) is mainly Chinese-American-United Kingdom with major contributions coming from India, Australia, and several European countries which demonstrate the worldwide yet uneven research effort.

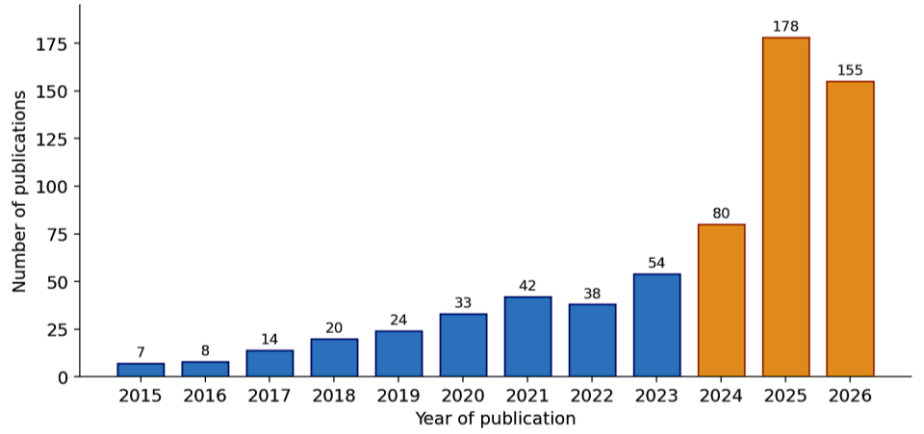

Figure 2. Research on digital surveillance and athlete data in sport

From 15 articles in 2015 to around 35 per year in recent years, an analysis of 1, 700 articles from Scopus (2015-2026) reveals a rapid increase in publication output with a noticeable jump starting from 2023 (the highlight). This is attributed to wearable analytics becoming a part of mainstream practice together with AI-powered monitoring indicating more awareness of the associated ethical and governance issues.

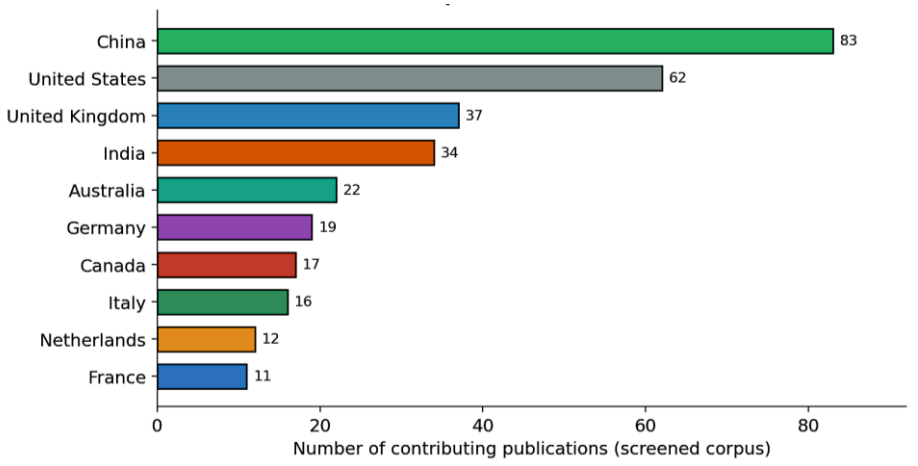

Figure 3. Map shows the geographical location of top ten countries contributing to the screened collection, determined according to first affiliation in metadata

Having a large chunk of the research concentrated in only a few countries suggests certain cultural and regulatory biases are likely to be present in the overall evidence base.

Table 3 This summary presents the ten studies that have been integrated. From bioethics and medical ethics to sports physiology, sports medicine, informatics, law, and leisure studies, the corpus is a rich mixture of these various disciplines and consists of both empirical and conceptual works. Table 3 presents the study of

each from the standpoints of research design, thematic focus, the type of technology or practice it has examined, and the chief outcome, which allows us to see how every study contributes one or several analytical themes.

Table 3. Summary of the ten included studies

Title (abridged)	Author(s)	Year	Country	Key finding
Tracking U.S. professional athletes: the ethics of biometric technologies	Karkazis & Fishman	2017	USA	Biometric monitoring is largely unregulated and threatens privacy, autonomy, and confidentiality.
Technology adoption and privacy concerns of wearables (running community)	Wiesner et al.	2018	Germany	Privacy and data-sharing features materially shape adoption and trust in wearables.
Analytics in sports medicine: the era of big data	Sikka et al.	2019	USA	Big-data analytics create new responsibilities for data stewardship and interpretation.
Wearables and the right to privacy and data protection	Kalinowska & Morawska	2019	Poland	Health data from wearables raise acute GDPR and personal-data-protection concerns.
Tracking oneself for others: sharing exercise data online	Ehrlén	2021	Finland	Self-tracking is socially motivated yet exposes personal data through networked sharing.
Smart mouthguards and contact sport: the data ethics dilemma	Gibson & Nelson	2025	UK	Safety-driven head-impact monitoring introduces consent and confidentiality dilemmas.
Invisible monitoring for athlete health and performance	Leduc & Weaving	2025	UK	"Invisible" monitoring reduces burden but obscures awareness and challenges consent.
Ethical bias in AI-driven injury prediction	Waśkiewicz et al.	2025	Poland	Five ethical concerns dominate AI injury prediction: privacy, fairness, consent, autonomy, governance.
Privacy-preserving AI for real-time health monitoring in sport	Chen & Xiao	2025	China	Federated and differentially private edge AI can protect biometric data during monitoring.
Artificial intelligence in sport: a narrative review	Zhou et al.	2025	UK/Australia	AI expands monitoring capability while intensifying data-privacy and ethical challenges.

Table 3 - Summary of the studies covered. All references are the exact ones provided in the Scopus export file; countries were taken according to the first author's affiliations. The body of work is multi- or better say interdisciplinary. It mixes empirical field research with more abstract and conceptual work and legal analyses too.

Table 4. Classification of included studies by design, theme, technology, and outcome

No	Author(s)	Year	Research design	Technology / practice	Theme (RQ)
1	Karkazis & Fishman	2017	Conceptual/ethics	Biometric player monitoring	Surveillance & autonomy (RQ1, RQ2)
2	Wiesner et al.	2018	Empirical field study	Consumer wearables	Privacy & adoption (RQ2)

No	Author(s)	Year	Research design	Technology / practice	Theme (RQ)
3	Sikka et al.	2019	Narrative review	Big-data analytics	Data stewardship (RQ1, RQ3)
4	Kalinowska & Morawska	2019	Legal analysis	Wearables / health data	Data protection (RQ2, RQ3)
5	Ehrlén	2021	Mixed methods	Self-tracking platforms	Dataveillance culture (RQ1, RQ2)
6	Gibson & Nelson	2025	Ethics analysis	Smart mouthguards	Consent & confidentiality (RQ2)
7	Leduc & Weaving	2025	Conceptual/position	Invisible monitoring	Surveillance intensity (RQ1, RQ2)
8	Waśkiewicz et al.	2025	Narrative review	AI injury prediction	Governance & fairness (RQ2, RQ3)
9	Chen & Xiao	2025	Design/technical	Edge & federated AI	Privacy-preserving tech (RQ3)
10	Zhou et al.	2025	Narrative review	AI across sport	Ethics & governance (RQ1, RQ3)

Table 4 - The themes and methodology in the selected papers were categorized accordingly. Mostly conceptual, legal aspects and review design are highlighted. Furthermore, more than one problem is being explored at the same time in the case of many of these studies which points to the fact that topics such as surveillance, privacy and governance are very much intertwined.

Of the ten included studies, six were conceptual papers (60%), two were narrative reviews (20%), one legal analysis (10%), and one empirical field study (10%). Most studies originated from Europe (50%) followed by North America (20%), Asia (20%), and Oceania (10%).

Figure 4 Shows the thematic clusters that the author of an overview of the literature identified. Most of the clusters are related issues of privacy, consent, and autonomy and the degree of biometric surveillance are discussed, whereas small but clear clusters of data governance, ownership, Algorithmic fairness, privacy-preserving technology, and self-tracking culture is also discussed. The clusters correspond to the three research questions and determine the organization of the synthesis here afterwards.

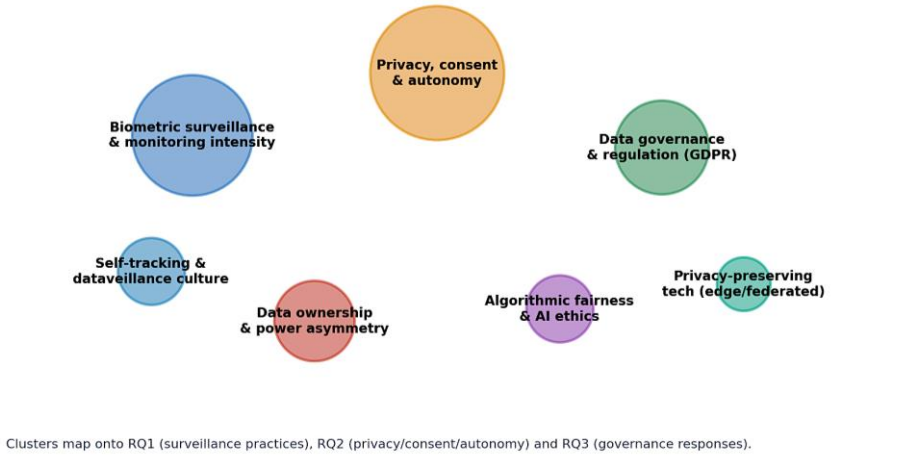

Figure 4. Differences between the ten studies in the frequency with which themes were discussed are shown below. The size of the bubble shows how often the theme was identified in the paper

Theme groups are also linked to the three research questions (RQ). Clusters under surveillance practices are the answers to RQ1. Privacy, consent, and autonomy are covered in answers to RQ2 while governance and technical solutions come under RQ3.

Thematic Synthesis

Findings for RQ1 - the nature and intensity of surveillance

There is a generally agreed image from the various studies on how monitoring, now, has become ubiquitous, ongoing, and even imperceptible. Karkazis and Fishman (2017) show that, for instance, through the use of technology, major professional organisations in sports have greatly expanded the collection of players'

biodata so that, for example observation goes way beyond a field of play and encompasses players' sleep, recovery as well as day to day life. Leduc and Weaving (2025) point out that the end-result of this process may be "invisible monitoring", where athletes are being tested continuously and without their knowledge or consent thus, staff work gets easier while, on the other hand, the athlete is completely unaware of being watched. In this case, we are talking of a change from occasional to a nearly permanent assessment state.

The technical infrastructure, of which this intensification is enabled by has very well capabilities that can be seen in similar sports-science publications. Position and inertial systems have been very effective in assessing external load and micro movements (Cummins et al., 2013; Delves et al., 2021; Sobreira et al., 2021; Rawashdeh et al., 2016), whereas wearables can now monitor physiological and biochemical parameters as well as recovery and injury-prevention data (Adesida et al., 2019; Cui et al., 2023; Seshadri et al., 2019; Vijayan et al., 2021; Yang et al., 2024). The main contribution of the recent analyses is the idea that each new stream of data constitutes simultaneously a new way of looking. Sikka et al. (2019) refer to the outcome environment of big data as a dual phenomenon where the carrying out one's duties increases and the amount of insights one gains also does, whereas Zhou et al. (2025) argue that AI-based monitoring has a broader analytical capability and a deeper level of surveillance.

This kind of study has been supported by other sociological researches. Changing athletes' bodies into constant streams of data is one typical case where datafication and the culture of dataveillance it brings (Lupton, 2016a; van Dijck, 2014) are evident. Also, using behavioral data for competitive/commercial purposes is in line with the idea of surveillance capitalism. Curran (2023; Zuboff, 2015). Other research conducted on people apart from high-level athletes has come to the same conclusion: Ehrlén (2021), for example, demonstrates that merely doing personal tracking will automatically bring people into visibility on networks, and works on university settings explain how long-existing institutional monitoring has come from technological enhancement to modernized surveillance (Comeaucomeaux, 2018; Corr & al., 2025). Therefore, the main insight is that, for a great deal, the athlete monitoring concept that literature puts forward is, indeed, beyond just a measurement; it is a set of practices that entail the continuous and, frequently, invisible observation.

Findings for RQ2 - privacy, consent, and autonomy

Privacy, consent and autonomy are identified as the main normative concerns throughout the corpus. Karkazis and Fishman (2017) hold the position that biometric monitoring not only violates players' privacy and keeps their sensitive information confidential but more importantly they lose their ability of self-determination as the practice is basically unregulated. Gibson and Nelson (2025) reveal that even the technologies clearly intended to improve safety such as smart mouthguards create a data-ethics dilemma because the same data which protects a player can disclose medical vulnerabilities and make the signing of a consent complicated. Waśkiewicz and team of researchers (2025) identify the AI injury prediction as the field where such problems occur repeatedly. They mention privacy and data handling, fairness in algorithm design, voluntary consent, the athletes' ability to make their own decisions and the control and handling of data in future times as the main ethical dilemmas.

A central and recurring insight is that consent in elite sport is often a structural rather than a real consent. Athletes being part of working or picking relationships make their freedom to decline surveillance very much limited and therefore getting their consent often a precondition of engagement and not really a sign of voluntary choice. Most clearly, Kwon (2025) brings up the issue of a power imbalance between players and teams leading consent to become a formality and data generated by players to a company property rather as a personal property. In line with the findings, privacy remains important at least for athletes who have to make their privacy decisions: Wiesner et al. (2018) discovered that individuals' decision to adopt wearables is largely influenced by the presence of privacy and data-sharing features, thus indicating that privacy is not a secondary concern but one of the main ones that determine engagement (cf. Neupert et al., 2025).

Autonomy as a key human right is being challenged by unchangeable and very rich to infer biometric data. Kalinowska and Morawska (2019) place wearable health data along with other private data under data protection laws such as GDPR, highlighting that such data are in a specially protected category. They argue that since the information derived from physiological data is capable of indicating the future state of health, wellbeing or deterioration, the revelation of such information to organisations enables them to get powerful positions that are difficult to reverse (Karkazis & Fishman, 2017). This issue is related to the larger discussion on privacy through information and the requirement for it in the autonomy of the person (Lupton, 2016b) as well as the critical examination of the potential for the classification and disciplinary application of biometric inference (Sánchez-Monedero & Dencik, 2022). The answer to RQ2 that one gets is therefore a literary

identification of a set of interlinking harms namely privacy invasion at a larger scale, compromised freedom to choose and autonomy loss that are getting more intense due to the existing power inequalities in society.

Findings for RQ3 - governance and mitigation

The third theme deals with the issue of making monitoring a way to enhance the athlete's performance without compromising their privacy. The literature review reveals three responses: technical, organisational, and regulatory. On the technical front, Chen and Xiao (2025) have shown that using privacy-preserving technologies (such as federated learning, differential privacy, and energy-efficient edge inference) can limit the exposure of sensitive biometric data by keeping it on or just near the athlete's device. This results in retaining the analytical power of the data without disclosing too much information. They also argue that such methods enable one to look at privacy as an aspect of design, not something that hinders performance monitoring, thus one can create monitoring systems by incorporating privacy as a design property.

According to scholars, the governance mechanisms at organisational and regulatory levels should be compulsory rather than voluntary. Kown (2025) suggested a co-ownership and data-sovereignty model in which rights and responsibilities over athlete data will be shared between athletes, clubs, leagues, technology companies, etc., and that data soveregnty should be a part of the regulation through club rules and federation policy. The emphasis on long-term data governance and the necessity for ethical AI deployment by way of explainable and auditable systems by Waśkiewic et al. (2024) is similar. Sikka et al.'s notion (2019) of data stewardship as a professional responsibility is echoed, and the view of Zhou et al. (2025) that ethical and organisational adoption should run alongside technical capabilities is the case. These notions are consonant with governance work in other sport contexts where measurement technologies are depicted to reshape the relationships of control and accountability (Gagnås & Bjørndal, 2025).

Behind these responses is an understanding of the fact that current safeguards do not match the speed of innovations. The regulation is scattered among various places and usually considers the athlete more as a subject of the data rather than being a data owner (Kalinowska & Morawska, 2019; Kwon, 2025). The authors of these works therefore propose a multifaceted governance model which is supported by privacy-by-design technology, meaningful and revocable consent, limitations of purpose, publicity, and a third-party supervisory body. The RQ3 question is being answered as follows: it is, in principle, possible to have an effective and robust mitigation, but in practice such protection varies widely from one situation to another, and it will take combined efforts from the areas of engineering technology, organizational policies, and law to finally achieve the full closure of the gap.

Comparative and Critical Analysis

In terms of methodologies, the majority of the available evidence that has been included leans towards conceptual, legal, and review articles, with little or no primary empirical research that features the voice of athletes. When such studies exist, they often focus on samples of people who engage in sport leisurely or who consume sport, like the work by Ehrlén (2021) and Wisesner et al. (2018), and it has been discussed quite controversially whether consumer-grade data recorders are valid and reliable even in non-athletes (Shei et al., 2022), as is often the case for elite athletes whose position for negotiation and who can be harmed differ greatly. This discrepancy results in an unequal situation regarding evidence: the moral aspects are being debated most vividly when it relates to top-class athletes, though the data available are more reliable for the non-top-class ones. Furthermore, the technical monitoring literature is well-established in methods but generally does not discuss issues related to data privacy (Akenhead & Nassis, 2016; Bourdon et al., 2017; Cardinale & Varley, 2017; Gabbett, 2016; Haller et al., 2022; Halson, 2014; Houtmeyers et al., 2021; Ravé et al., 2020), thus confirming the problem of separate strands identified in the introduction.

Beyond content and theoretical shifts, also the methodology of research on this topic has changed in terms of time and focus. Initially, researchers considered these issues as novel and largely uncontrollable situations (Karkazis & Fishman, 2017), while later works are oriented to the design of moral framework concepts and proposals of how rules and regulations for governing should be developed (Chen & Xiao, 2025; Kwon, 2025; Waśkiewicz et al, 2023). This pattern of changes is similar to the peak of scientific activity described in Figure 2. It is likely that this indicates a discipline evolving from recognizing new problems to the designing new means for problem solving. However, longitudinal study designs as well as comparative design are still uncommon, and the few examples of athletes involved in governance of their sport through assessment of these mechanisms present a methodological area of research (Girard & Faude, 2022; Neupert et al., 2025), that definitely needs strengthening.

Discussion

Together they explain that digital surveillance in elite sports is not a coincidental feature of performance technology but rather a characteristic of modern training environments. The increased level of surveillance, the unethical consequences, and the governance issues all make for an overall picture in which it is the technical capabilities that have outpaced the social and legal frameworks which would legitimize their use.

In theory, the review is an attempt to carry forward the ideas of datafication, dataveillance, and surveillance capitalism in their athletic manifestations. The athletic body serves as a very good example precisely because the data generated are as much biological as they are professional, as private as they are commercially valuable, and this combination of facets raises questions as to the ownership, the consent that one can really speak of in a way that the traditional notion of privacy may still be insufficiently equipped to deal with. It is, therefore, through the review that one sees limitations in purely instrumental approaches to monitoring and recognizes that measurement is also a form of looking which is a kind of an observer's act that causes distributional and relational effects (Alzahrani & Ullah, 2024; Seshadri et al., 2021).

In a way that is close to reality, this finding is practical and could even be applied directly. It suggests to all types of workers that besides monitoring programmes the transparent explanation of what the programme is used for, keeping the collection of data to an absolute minimum and giving the athlete a chance either to ask questions or reject the programme altogether should be part of it (Leduc & Weaving, 2025; Neupert et al., 2025). On the organisational or governmental level, these ideas also support the introduction of such privacy-by-design technology that does not give any chance of invading privacy (Chen & Xiao, 2025), the implementation of a valid consent form and the restriction of collection of data from the perspective of data-protection law (Kalinowska & Morawska, 2019); and governance mechanisms that not only consider the athletes as the main stakeholders of the whole data but also respect them as such (Kwon, 2025; Waśkiewicz et al., 2025).

Contrasting with previous research, which has mainly focused on the technical aspects of monitoring systems (Cummins et al., 2013; Felipe et al., 2021; Seçkin et al., 2023), on one hand, or, on the other hand, the more general culture of self-tracking (Lupton, 2016b), this work is the first to bring those two areas together in the specific context of elite-athlete surveillance and privacy. The review not only confirms the view from the technical angle regarding the possibilities of monitoring, but especially brings up the moral (ethics, privacy) and legal aspects (governance) of those monitoring capabilities, which the technological literature more often than not overlooks.

Till now, the literature is still full of contradictions. They describe the same technologies as protective and also as intrusive; smart mouthguards, for instance, are a safety improvement but also a source of ethical hazard (Gibson & Nelson, 2025). According to some authors, consent is a genuine means of protection and for others almost a piece of decoration (Kwon, 2025). The privacy-preserving computation is even proposed as a fix by critics who have highlighted that technically limiting exposure alone will not answer questions of power and ownership (Chen & Xiao, 2025; Sánchez-Monedero & Dencik, 2022). In the end, those contradictions are just because of different disciplines rather than empirical disagreement. Thus it is very good reason to do an integrative synthesis that encompasses all those diverse perspectives.

There are three aspects that are yet to be explored thoroughly. Firstly, not many of these studies investigate from the perspective of the elite athletes and their daily experience, the use of monitoring and the nature of their consent. Secondly, there is a lack of practical application of governance proposals making it impossible for us to evaluate their real-world effectiveness. And third, there has been only minimal comparison between different countries' approaches in sport regulation given that sport is a worldwide industry whereas the majority of evidence is from only a few countries (see Figure 3).

There are several limitations of this review that must be pointed out. Relying on just one database, Scopus, could mean that we've missed some relevant works that are indexed on other platforms; limiting our sources to English language articles and reviews could have been biased in terms of language and publication; and the final sample size, although the result might be very specific if the theme is focused to a certain degree, is just one small step away from limiting the usefulness of the findings for the wider audience. A few extra references were added from the wider literature to help frame the synthesis and they were crosschecked against primary sources instead of being made up.

The future research agenda is therefore very straightforward. First, more research is needed focusing entirely on the athlete (i.e. through empirical work on athlete perspectives; as well as exploring the legitimisation and experience of monitoring). Secondly, we need to study different ways of governance, such

as co-ownership, consent architectures, and independent oversight, in order to foresee whether these are effective. Third, it is necessary to conduct comparative legal and policy analyses across jurisdictions and sporting bodies. Tackling these three issues would help the discipline to move further from only identifying problems to showing actual solutions.

To answer its three questions, the article can be summarized. Elite sports digital monitoring has reached its peak and is becoming more and more unnoticeable (RQ1). It produces complex damages to privacy, consent, autonomy which get worse due to structural power imbalance (RQ2), and although different ways of technical, organizational, and regulatory interventions are available, they are still incomplete and a combined implementation is needed (RQ3).

Conclusions

The work done is a critical review of the existing digital tracking literature through ten studies, to reveal the concept of the two phenomena, digital surveillance, and athletes privacy, within the context of elite sport. In respect to the first question, surveillance is now so much a background and an everyday tool that most of the time one is unaware of being constantly monitored. Therefore measurement is no more a way to gather individual data but a means of a power regime that gets stronger and stronger. Regarding the second question, a three-fold harm is identified in the literature reduced personal privacy, invalidated and not freely given consent through, and diminished autonomy. The literature points out that this has happened especially because of the pressures, employment, and competitions under which athletes can hardly make the decision of their own, such as the refusal option. Concerning the third question, the research shows that privacy-preserving technologies, such as co-ownership, and data-sovereignty governance, are the most realistic solutions at the technical, organisational, and regulatory levels. However, the problem is that they are not evenly applied and they are lagging behind the current technology level. By bringing together the sports-science literature on the one hand, with the critical/social-science literature on the other, the review reveals the extent to which these two are interdependent and that to some extend, surveillance equals power and control. The findings of this paper suggest that the following are necessary elements: design of technology for privacy, the use of substantive, revocable consent, limitations of the purposes of the data collected, transparency, and independent supervision when one wants to set up data governance that places athletes at its heart. The review's only downside is that it is limited to a single source, articles in an English language, and it has also a very small and narrow sample. Therefore, conclusions must also be considered in relation to these limitations. Future work should mainly focus on gathering empirical evidence from the athletes' side, doing prospective assessments of the functioning of governance, and undertaking a cross-jurisdictional regulatory analysis. This review has several limitations. First, only Scopus-indexed publications were included, potentially excluding relevant studies indexed elsewhere. Second, only English-language peer-reviewed articles were reviewed. Third, the final synthesis included only ten studies, limiting generalizability. Future reviews should include Web of Science, PubMed, and multidisciplinary databases while expanding empirical evidence from elite athletes. Thus, the benefits of surveillance can be taken advantage of without any compromise on the legal rights and the dignity of the people whose data is being collected and used.

Acknowledgments

The Authors would like to thank Faculty of Sport Sciences, Universitas Negeri Padang for providing excellent facilities, as well as for being very supportive of this research from the beginning. Authors also thank the team members who had generously shared their brilliant ideas, engaging discussion, and academic supports during the study.

References

Chen, K., & Xiao, L. (2025). Energy-efficient privacy-preserving AI models for real-time health monitoring in mobile IoT networks for professional sports applications. Discover Applied Sciences, 7, Article 626. https://doi.org/10.1007/s42452-025-07626-6

Ehrlén, V. (2021). Tracking oneself for others: Communal and self-motivational value of sharing exercise data online. Leisure Studies, 40(3), 344–358. https://doi.org/10.1080/02614367.2020.1869289

Gibson, R. B., & Nelson, A. (2025). Smart mouthguards and contact sport: The data ethics dilemma. Journal of Medical Ethics. Advance online publication. https://doi.org/10.1136/jme-2024-110104

Kalinowska, N., & Morawska, K. (2019). Wearables in the context of the right to privacy and data protection - Research results and conclusions. Jusletter IT.

Karkazis, K., & Fishman, J. R. (2017). Tracking U.S. professional athletes: The ethics of biometric technologies. The American Journal of Bioethics, 17(1), 45–60. https://doi.org/10.1080/15265161.2016.1251633

Leduc, C., & Weaving, D. (2025). Invisible monitoring for athlete health and performance: A call for a better conceptualization and practical recommendations. International Journal of Sports Physiology and Performance. Advance online publication. https://doi.org/10.1123/ijspp.2024-0292

Sikka, R. S., Baer, M., Raja, A., Stuart, M., & Tompkins, M. (2019). Analytics in sports medicine: Implications and responsibilities that accompany the era of big data. The Journal of Bone and Joint Surgery. American Volume, 101(3), 276–283. https://doi.org/10.2106/JBJS.17.01601

Waśkiewicz, Z., Słomka, K. J., Grzywacz, T., & Juras, G. (2025). Ethical bias in AI-driven injury prediction in sport: A narrative review of athlete health data, autonomy and governance. AI, 6(11), Article 283. https://doi.org/10.3390/ai6110283

Wiesner, M., Zowalla, R., Suleder, J., Westers, M., & Pobiruchin, M. (2018). Technology adoption, motivational aspects, and privacy concerns of wearables in the German running community: Field study. JMIR mHealth and uHealth, 6(12), e201. https://doi.org/10.2196/mhealth.9623

Zhou, D., Keogh, J. W. L., Ma, Y., Tong, R. K. Y., Khan, A. R., & Jennings, N. R. (2025). Artificial intelligence in sport: A narrative review of applications, challenges and future trends. Journal of Sports Sciences. Advance online publication. https://doi.org/10.1080/02640414.2025.2518694

Adesida, Y., Papi, E., & McGregor, A. H. (2019). Exploring the role of wearable technology in sport kinematics and kinetics: A systematic review. Sensors, 19(7), Article 1597. https://doi.org/10.3390/s19071597

Akenhead, R., & Nassis, G. P. (2016). Training load and player monitoring in high-level football: Current practice and perceptions. International Journal of Sports Physiology and Performance, 11(5), 587–593. https://doi.org/10.1123/ijspp.2015-0331

Alzahrani, A., & Ullah, A. (2024). Advanced biomechanical analytics: Wearable technologies for precision health monitoring in sports performance. Digital Health, 10. https://doi.org/10.1177/20552076241256745

Bourdon, P. C., Cardinale, M., Murray, A., Gastin, P., Kellmann, M., Varley, M. C., Gabbett, T. J., Coutts, A. J., Burgess, D. J., Gregson, W., & Cable, N. T. (2017). Monitoring athlete training loads: Consensus statement. International Journal of Sports Physiology and Performance, 12(s2), S2-161–S2-170. https://doi.org/10.1123/IJSPP.2017-0208

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Cardinale, M., & Varley, M. C. (2017). Wearable training-monitoring technology: Applications, challenges, and opportunities. International Journal of Sports Physiology and Performance, 12(s2), S255–S262. https://doi.org/10.1123/ijspp.2016-0423

Comeaux, E. (2018). Stereotypes, control, hyper-surveillance, and disposability of NCAA Division I Black male athletes. New Directions for Student Services, 2018(163), 33–42. https://doi.org/10.1002/ss.20268

Corr, C., Stokowski, S., Staurowsky, E. J., Paule-Koba, A. L., & Southall, R. M. (2025). The modernization of monitorization: Technological adaption and innovation as mechanisms for college athlete surveillance. International Review for the Sociology of Sport. Advance online publication. https://doi.org/10.1177/01937235251330206

Cui, J., Du, H., & Wu, X. (2023). Data analysis of physical recovery and injury prevention in sports teaching based on wearable devices. Preventive Medicine, 173, Article 107589.

Cummins, C., Orr, R., O'Connor, H., & West, C. (2013). Global positioning systems (GPS) and microtechnology sensors in team sports: A systematic review. Sports Medicine, 43(10), 1025–1042. https://doi.org/10.1007/s40279-013-0069-2

Curran, D. (2023). Surveillance capitalism and systemic digital risk: The imperative to collect and connect and the risks of interconnectedness. Big Data & Society, 10(1). https://doi.org/10.1177/20539517231177621

Delves, R. I. M., Aughey, R. J., Ball, K., & Duthie, G. M. (2021). The quantification of acceleration events in elite team sport: A systematic review. Sports Medicine – Open, 7, Article 45. https://doi.org/10.1186/s40798-021-00332-8

Felipe, J. L., Garcia-Unanue, J., Gallardo, L., & Sanchez-Sanchez, J. (2021). Tracking systems used to monitor the performance and activity profile in elite team sports. Sensors, 21(24), Article 8251. https://doi.org/10.3390/s21248251

Gabbett, T. J. (2016). The training–injury prevention paradox: Should athletes be training smarter and harder? British Journal of Sports Medicine, 50(5), 273–280. https://doi.org/10.1136/bjsports-2015-095788

Gagnås, H. L., & Bjørndal, C. T. (2025). The impact of the academy classification model on coaching practices in Norwegian football: A Foucauldian analysis of governance and player development. Sports Coaching Review. Advance online publication. https://doi.org/10.1080/21640629.2025.2550837

Girard, O., & Faude, O. (2022). Editorial: Insights in elite sports and performance enhancement: 2021. Frontiers in Sports and Active Living, 4, Article 960538. https://doi.org/10.3389/fspor.2022.960538

Haller, N., Blumkaitis, J. C., Strepp, T., Schmuttermair, A., Aglas, L., Simon, P., Neuberger, E., Kranzinger, C., Kranzinger, S., O'Brien, J., Ergoth, B., Raffetseder, S., Fail, C., Düring, M., & Stöggl, T. (2022). Comprehensive training load monitoring with biomarkers, performance testing, local positioning data, and questionnaires — First results from elite youth soccer. Frontiers in Physiology, 13, Article 1000898. https://doi.org/10.3389/fphys.2022.1000898

Halson, S. L. (2014). Monitoring training load to understand fatigue in athletes. Sports Medicine, 44(Suppl. 2), S139–S147. https://doi.org/10.1007/s40279-014-0253-z

Houtmeyers, K. C., Vanrenterghem, J., Jaspers, A., Ruf, L., Brink, M. S., & Helsen, W. F. (2021). Load monitoring practice in European elite football and the impact of club culture and financial resources. Frontiers in Sports and Active Living, 3, Article 679824. https://doi.org/10.3389/fspor.2021.679824

Kwon, J. W. (2025). Athlete data sovereignty: Addressing the legal and policy gaps in sports technology. Frontiers in Sports and Active Living, 7, Article 1742484. https://doi.org/10.3389/fspor.2025.1742484

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. PLoS Medicine, 6(7), Article e1000100. https://doi.org/10.1371/journal.pmed.1000100

Lupton, D. (2016a). The diverse domains of quantified selves: Self-tracking modes and dataveillance. Economy and Society, 45(1), 101–122. https://doi.org/10.1080/03085147.2016.1143726

Lupton, D. (2016b). The quantified self: A sociology of self-tracking. Polity Press.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. PLoS Medicine, 6(7), Article e1000097. https://doi.org/10.1371/journal.pmed.1000097

Neupert, E. C., Holder, T., & Jobson, S. A. (2025). Evaluating a behaviour change intervention to enhance athlete monitoring system engagement: Insights from elite sport. International Journal of Sports Science & Coaching. Advance online publication. https://doi.org/10.1177/17479541251338804

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, Article n71. https://doi.org/10.1136/bmj.n71

Ravé, G., Granacher, U., Boullosa, D., Hackney, A. C., & Zouhal, H. (2020). How to use global positioning systems (GPS) data to monitor training load in the "real world" of elite soccer. Frontiers in Physiology, 11, Article 944. https://doi.org/10.3389/fphys.2020.00944

Rawashdeh, S. A., Rafeldt, D. A., & Uhl, T. L. (2016). Wearable IMU for shoulder injury prevention in overhead sports. Sensors, 16(11), Article 1847. https://doi.org/10.3390/s16111847

Sánchez-Monedero, J., & Dencik, L. (2022). The politics of deceptive borders: "Biomarkers of deceit" and the case of iBorderCtrl. Information, Communication & Society, 25(3), 413–430. https://doi.org/10.1080/1369118X.2020.1792530

Seçkin, A. Ç., Ateş, B., & Seçkin, M. (2023). Review on wearable technology in sports: Concepts, challenges and opportunities. Applied Sciences, 13(18), Article 10399. https://doi.org/10.3390/app131810399

Seshadri, D. R., Li, R. T., Voos, J. E., Rogers, J. A., Drummond, C. K., & Colbert, C. Y. (2019). Wearable sensors for monitoring the physiological and biochemical profile of the athlete. npj Digital Medicine, 2, Article 71. https://doi.org/10.1038/s41746-019-0149-2

Seshadri, D. R., Thom, M. L., Harlow, E. R., Gabbett, T. J., Geletka, B. J., Hsu, J. J., Drummond, C. K., Phelan, D. M., & Voos, J. E. (2021). Wearable technology and analytics as a complementary toolkit

to optimize workload and to reduce injury burden. Frontiers in Sports and Active Living, 2, Article 630576. https://doi.org/10.3389/fspor.2020.630576

Shei, R.-J., Holder, I. G., Oumsang, A. S., Paris, B. A., & Paris, H. L. (2022). Wearable activity trackers — Advanced technology or advanced marketing? European Journal of Applied Physiology, 122(9), 1975–1990. https://doi.org/10.1007/s00421-022-04951-1

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. BMC Medical Research Methodology, 8, Article 45. https://doi.org/10.1186/1471-2288-8-45

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. British Journal of Management, 14(3), 207–222. https://doi.org/10.1111/1467-8551.00375

van Dijck, J. (2014). Datafication, dataism and dataveillance: Big data between scientific paradigm and ideology. Surveillance & Society, 12(2), 197–208. https://doi.org/10.24908/ss.v12i2.4776

Vijayan, V., Connolly, J. P., Condell, J., McKelvey, N., & Gardiner, P. (2021). Review of wearable devices and data collection considerations for connected health. Sensors, 21(16), Article 5589. https://doi.org/10.3390/s21165589

Yang, G., Hong, J., & Park, S.-B. (2024). Wearable device for continuous sweat lactate monitoring in sports: A narrative review. Frontiers in Physiology, 15, Article 1376801. https://doi.org/10.3389/fphys.2024.1376801

Zuboff, S. (2015). Big other: Surveillance capitalism and the prospects of an information civilization. Journal of Information Technology, 30(1), 75–89. https://doi.org/10.1057/jit.2015.5

Zuboff, S. (2019). The age of surveillance capitalism: The fight for a human future at the new frontier of power. PublicAffairs.