Grand Slams, Small Samples: The Evidence Gap in Professional Tennis

Jaime Fernandez-Fernandez [1, 2]

[1] Department of Physical Activity and Sport Sciences, Universidad de León, Spain
[2] Analysis of Human Movement, Sports Performance, and Health Research Group (AMREDyS), Universidad de León, Spain

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Headline

Professional tennis is widely portrayed as a technologically advanced, "scientific" environment, yet the empirical evidence directly involving ranked players from the Association of Tennis Professionals (ATP) and the Women's Tennis Association (WTA) is surprisingly limited. Much of what is currently used to guide practice still comes from juniors, sub-elite players or simulated match play, even though the competitive calendar, travel demands and match densities at the professional level are markedly different.

Aim

This paper aims to: (1) summarize current scientific evidence specifically involving professional players, drawing on Grand Slam tracking studies, physiological case reports, training interventions, longitudinal developmental case studies and tour-level injury surveillance; and (2) highlight the main gaps and biases in this evidence base, in order to outline realistic directions for future research.

Discussion

Professional tennis increasingly presents itself as a highly "scientific" environment (1). Players frequently travel with support staff using global positioning system (GPS) units, velocity-based devices, heart-rate (HR) monitors and a range of recovery technologies, and performance content on social media often features testing, data dashboards and biomechanical analyses, although much of this material is anecdotal and not clearly grounded in scientific evidence. Importantly, the presence of technology does not guarantee that training and decision-making are systematically informed by the scientific method or by robust empirical data.

Public statements from high-profile players, such as Novak Djokovic's references to exploring new methods and technologies to extend his career, reinforce the idea that performance margins are small and that competitive advantage may be found in increasingly sophisticated support strategies. However, when one examines the peer-reviewed literature, a different picture emerges. Despite this apparent technological sophistication, ATP- and WTA-ranked players remain relatively under-represented in published datasets, and much of the evidence used to guide practice is still derived from youth (2), sub-elite (3–5), or simulated-tennis studies (6,7). These studies are valuable and often provide important contextual information, but direct extrapolation to professional tennis is problematic because the competitive calendar, travel loads, environmental constraints and financial incentives differ markedly between levels (8). This disconnection is not merely an academic issue; it has practical implications for how training is prescribed, how seasons are planned, how information is communicated to coaches, and ultimately how players' performance and career longevity are supported. At the same time, existing work already shows that rigorous scientific methods can be applied successfully in professional tennis.

What do we actually know about professional players?

Rather than systematically reviewing all tennis research, this commentary maps the main domains in which empirical data currently exist specifically for professional players: (1) Grand Slam match-play and movement demands; (2) training interventions and long-term development; (3) physiological case reports of match play; and (4) tour-level injury and illness surveillance. This "islands of evidence" view helps to clarify both what is known and what remains largely undescribed in ATP/WTA populations.

Work based on Hawk-Eye data from the Australian Open illustrates how precisely Grand Slam match play can be characterized. Across several tournament editions, player- and ball-tracking analyses have consistently identified clear sex differences, with men serving and returning differently to women and moving at higher average speeds despite covering similar distances per point (9,10). Over the first four rounds of the same Grand Slam, male players also accumulate substantially greater total distance and shot volume and experience progressive increases in game-level workload and effective playing time (11).

More recent analyses have refined this picture. Armstrong et al. (12) quantified typical between-shot movement distances of approximately 4.2–4.5 m in Grand Slam singles, highlighting how total match distance scales with match format and competitiveness. In parallel, several studies have applied machine-learning and clustering techniques to professional match play, differentiating movement styles and change-of-direction profiles (13–15). Distinct patterns of lateral and multidirectional movement have been described, with some players covering a greater proportion of distance through wide, lateral changes of direction and others relying more on shorter adjustment steps and smaller displacements between strokes. These profiles are associated with different external-load characteristics (e.g., frequency of high-intensity changes of direction, peak speeds and decelerations), suggesting that players can achieve similar performance outcomes through qualitatively different movement solutions (13). Importantly, wide lateral actions appear to represent some of the most demanding movement tasks, with higher peak speeds and decelerations generally associated with reductions in shot quality, although top-10 players seem better able to preserve shot quality at higher movement speeds than lower-ranked peers (16).

On the training side, the available evidence is even more limited. To the best of our knowledge, only two studies have conducted experimental interventions in professional players (17,18). The inclusion of sport-specific high-intensity interval sessions during the pre-season period (i.e., a shock microcycle) led to significant improvements in intermittent fitness (30–15 test) and repeated-sprint ability (RSA) in ATP-ranked players (17). Repeated-sprint training in hypoxia (RSH) provides complementary evidence in ATP-level players, with improvements in time to exhaustion, lactate kinetics, ball accuracy at maximal intensity and RSA following five tennis-specific RSH sessions over 12 days (18). From a physiological standpoint, these adaptations are broadly consistent with those seen in high-level juniors and sub-elite adults, reinforcing the notion that technical-tactical proficiency, rather than extreme physical capacities, often differentiates performance levels in tennis. Nevertheless, such interventions remain rare examples of training being manipulated and evaluated directly in professional players and therefore provide important starting points for understanding dose–response relationships in this population.

Injury-related data offer another example of both progress and limitation. Large-scale epidemiological work using medical records from Grand Slam events and WTA/ATP tournaments has described injury incidence and profiles in professional players, showing that musculoskeletal injuries, particularly to the lower limb and shoulder (19), are common and that rates vary by surface, tournament category and sex (20). More recent analyses of retirements and medical withdrawals suggest that incidence has increased over time in some parts of the professional calendar and that previous injury, competitive level and environmental factors such as heat are important modifiers (21). Comparisons with junior and sub-elite cohorts indicate that patterns and severity may differ between competitive levels, but the extent to which these differences reflect playing exposure, physical preparation or monitoring practices remains unclear (22). These surveillance studies are invaluable for medical planning and risk stratification, yet they typically provide limited information about specific training exposures, load-management strategies or physical preparation practices, again highlighting how much remains unknown about the mechanisms linking training, competition and health in this population.

Why is the evidence base so limited?

Conducting research with ATP- and WTA-ranked players presents a series of practical and contextual challenges that help explain their limited representation in the literature. Access and trust are central. Professional players and their teams are understandably cautious about sharing performance and health-related information, particularly when small changes in form or perceived injury risk may have direct implications for rankings, contracts and public perception. In this context, making internal load data or medical information publicly available can be perceived as risky rather than beneficial.

The structure of the professional calendar adds further complexity. An extended competitive season across multiple continents and playing surfaces leaves little scope for tightly controlled experimental designs. Tournament schedules, draws and surfaces change almost every week, and factors such as jet lag, late finishes or travel disruptions often interfere with the timing of assessments. Even simple pre–post testing protocols become difficult to implement consistently. Paradoxically, these same constraints define some of the most important questions for applied research, how best to manage load, recovery and performance across crowded, multi-surface seasons, yet they are the hardest to study with traditional randomized designs. Staffing and role distribution within teams also constrain research activity. Particularly outside the very top rankings, the same practitioner may be responsible for strength and conditioning, data collection and analysis, and logistical coordination. Under such circumstances, the extra workload involved in designing studies, ensuring data quality and preparing manuscripts is difficult to absorb, even when practitioners operate with a clear scientific mindset. In parallel, some cultural distance remains between parts of the tennis community and academia, with research occasionally viewed as remote from "real-world" tennis and with some researchers underestimating the time and relationship-building required to work effectively in elite environments.

Finally, there is a historical tendency for tennis research to gravitate toward questions and settings that are easier to control, isolated physical tests or simulated match play, rather than the complex, ecologically valid problems that practitioners face, such as managing neuromuscular fatigue over consecutive tournament weeks, understanding the specific demands on doubles specialists with smaller entourages, or periodizing in the context of a dense, multi-surface competitive schedule. Rather than viewing these constraints as excuses, they should be understood as design parameters that point towards more creative, practice-oriented approaches: prospective observational cohorts, repeated single-case and small-n studies, nested case–control analyses and carefully designed quasi-experiments that better align with the realities of life on tour.

If one accepts that ATP- and WTA-ranked players are under-represented in the published literature, practitioners embedded within professional teams are well placed to help close this gap. Recent single- and small-case reports in elite and professional players demonstrate how much can be learned when routine information is systematically collected and analyzed, even in very small samples. Examples include longitudinal descriptions of training volume and content in a multiple Grand Slam finalist (23), case studies linking preseason aerobic fitness to year-end ATP ranking (24), or detailed physiological monitoring during Davis Cup–level match play (25). Routine monitoring of training load, wellness, travel, simple performance tests and injury status is already commonplace. With moderate additional effort, standardizing variables, ensuring data quality and safeguarding confidentiality, these data streams can be converted into informative single-case reports, small prospective cohorts or multicenter collaborations. Periods of relative stability, such as preseason or defined training blocks, offer particular opportunities to embed research questions within planned overload or taper phases, as illustrated by existing work on high-intensity microcycles in elite players (17). At a broader level, journals, federations and tours can facilitate progress by recognizing the value of rigorously conducted applied studies from professional environments, even when sample sizes are small and designs are observational, provided that contextual information is rich and methods are transparent. Long-term, trust-based relationships between researchers, governing bodies and practitioners, such as those underpinning Grand Slam tracking and injury-surveillance projects, are likely to be essential for generating and sharing high-quality data on this population.

Conclusions

Professional tennis is characterized by substantial competitive, travel and surface-related demands, yet the body of high-quality empirical work specifically involving ATP- and WTA-ranked players remains relatively small. Existing studies have generated detailed descriptions of Grand Slam match-play and workloads, provided initial insights into how elite players respond to structured overload and hypoxic repeated-sprint interventions, and begun to chart injury patterns and long-term developmental trajectories in world-class performers. These contributions offer important anchor points but do not yet amount to a comprehensive evidence base for the professional game. Building on current work through practitioner-led case studies, prospective observational projects and research embedded in real training blocks, supported by journals, federations and tours, offers a realistic pathway toward a more robust and practically relevant evidence base to support performance and health in professional tennis.

Practical Applications

From a practical standpoint, the arguments developed in this article suggest several implications for those working with professional players. First, professional players should be treated as a distinct population when interpreting and applying evidence. The Grand Slam tracking studies, training interventions, case reports and injury-surveillance data summarized above can serve as important anchor points, but extrapolation from junior, recreational or simulated-tennis samples should be undertaken cautiously and always with reference to the specific calendar and context of the tour. Second, in light of the logistical constraints described earlier (busy travel schedules, frequent surface changes and small support teams), monitoring systems in professional tennis are likely to be most effective when they are simple and sustainable, combining tools such as session rating of perceived exertion (RPE), basic exposure metrics (e.g., time on court, matches, sets and GPS/Hawk-Eye data when available) and a small number of pragmatic performance tests (e.g., jumps or short sprints), rather than relying on complex protocols that are difficult to maintain on tour. Third, adopting a "case-study mindset" in daily work—defining clear questions, collecting data consistently and documenting contextual factors—aligns with the types of designs that are most feasible in elite environments and can both improve decision-making locally and generate datasets that later support formal single-case, small-cohort or multicenter publications. Finally, given the current gaps in the evidence base, being explicit with players and coaches about the limits of existing knowledge, and using this transparency as a starting point for collaborative, structured experimentation, may be preferable to presenting indirect evidence as more definitive than it truly is.

Key points

- Despite the widespread use of technology on tour, peer-reviewed evidence directly involving ATP/WTA-ranked players remains limited and clustered in a small number of contexts and designs.
- The strongest professional data come from centralized projects (e.g., Grand Slam tracking) and injury surveillance, whereas intervention evidence and training dose–response data are still scarce.
- Extrapolation from juniors, sub-elite cohorts or simulated match play can be informative, but should be made cautiously given the unique professional calendar (travel, surfaces, match density).
- Realistic tour-compatible designs (single-case, small-N, multi-center observational cohorts, and research embedded within real training blocks) are the most pragmatic routes to closing the evidence gap.
- Turning routine monitoring into publishable, context-rich applied science—through basic standardization and confidentiality safeguards—is an immediately actionable opportunity.

Conflicts of interest

The author declare no conflicts of interest related to the content of this article.

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