

Cultivation Status, Constraints, and Enhancement Pathways of Tennis Referees in Guangxi: A Regional Development Perspective

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Abstract

This study examines the cultivation of tennis referees in Guangxi, China, through a mixed-methods approach. Results reveal a system trapped in “systemic stagnation”. While basic training exists, it focuses narrowly on rule dissemination, lacking essential modules in psychology, technology, and practical decision-making. Promotion mechanisms are opaque, and high-level officiating opportunities are unevenly distributed. Crucially, the system fails to develop competencies aligned with Guangxi’s regional realities - particularly English communication for Association of Southeast Asian Nations (ASEAN)-facing events and adaptive skills for its multi-ethnic context. We argue that moving beyond this stagnation requires a fundamental paradigm shift: from standardized training to building an adaptive, region-sensitive cultivation ecosystem that responds to local strategic needs and empowers referees across generation.

Keywords

Referees, Regional development, Social closure, Cultivation system

Introduction

The professional construction of tennis referees has become an important link in promoting the high-quality development of tennis in China. In today’s parallel era of professional events and national fitness events, the referee’s ability to referee is not only related to the fairness of a single game, but also affects the overall image and development potential of regional tennis [1]. Existing research mainly focuses on economically developed regions (such as Zhejiang and Sichuan) and national referee groups, forming a relatively mature theoretical system and practice model. However, the objective reality of uneven regional development in our country determines that different regions are facing differentiated challenges and needs.

As an important hub connecting China and Association of Southeast Asian Nations (ASEAN), the development of tennis in Guangxi Zhuang Autonomous Region has both endogenous needs and outward-looking opportunities. On the one hand, the increasingly active events of universities and amateur clubs in the region put forward general requirements for the number of referees and basic refereeing ability. On the other hand, international sports exchange activities for ASEAN have gradually increased, posing new challenges to referees’ foreign-related refereeing ability and cross-cultural

communication literacy. The related study of amateur tennis in Guangxi reveals the social basis for the development of the project, there is still a lack of systematic research on the professional group of tennis referees in the region [2].

This lack of research may lead to a lack of empirical basis for policy formulation and practice promotion. If the training model of developed regions is simply applied, key variables such as Guangxi’s unique geographical environment, event structure, economic support and multi-ethnic cultural background may be ignored. Therefore, clarifying the real picture of Guangxi tennis referee training and analyzing the regional particularity of its constraints is not only the need to fill the academic gap, but also the prerequisite for the precise training of regional sports talents.

Based on the perspective of regional development, this study aims to systematically answer the following questions through empirical investigation: First, what is the current status of the training system of tennis referees in Guangxi (including selection, training, assessment, management and other links)? Second, what are the main constraints affecting their professional ability improvement and career development? How do these factors compare to the rest of the country? Third, based

on the current situation and constraints, how to build a sustainable referee ability improvement path that is in line with the reality of Guangxi [3]? Through the discussion of these issues, this study hopes to provide theoretical reference and practical guidance for the professional development of tennis referees in Guangxi.

Literature review

As an important branch of sports management, the theoretical evolution of tennis referee research presents a clear context from experience summary to scientific construction, from universal discussion to contextual analysis. Through the review of relevant literature at home and abroad, this study finds that this field mainly revolves around three core dimensions, which together constitute a theoretical lens for analyzing the development of regional tennis referees.

Scientific construction of competency standards and evaluation system

Early research focused on the interpretation of referee rules and the induction of adjudication techniques. With the development of sports science, the school community has begun to try to deconstruct and quantify the ability of referees. Korean scholars Yoon & Kim used the Delphi method and analytic hierarchy process to construct an evaluation system containing five first-level indicators and 18 second-level indicators, including professional ethics, business knowledge, on-the-spot judgment, psychological quality, and physical fitness [4]. International studies also show similar trends, such as the “decision-making model” proposed by Raab et al., which emphasizes situational cognition and rapid information processing under pressure [5]. Such studies provide a rigorous measurement tool for evaluating the baseline of referees in Guangxi, but how its universal index system adapts to the unique event environment of Guangxi (such as amateur events, hot and humid climate, etc.) still needs to be further tested and adjusted.

Differentiated exploration of training mode and management mechanism

On the basis of system construction, scholars began to pay attention to the effectiveness of the training model and the rationality of the management mechanism [6]. Armenteros revealed the advantages of the “government-association-university” collaborative training model, and also pointed out the uneven distribution of grassroots training resources and the single promotion channel [7].

This finding has important implications: Even in economically developed areas, the training system is not perfect. From an international perspective, the “apprenticeship” and stepped promotion system of professional tennis referees in Europe and the United States emphasize long-term practice and mentorship, which is in contrast to the domestic model of short-term training and theoretical assessment. Li Longxi & Li Yanfeng pointed out from the macro management level that there is a contradiction between “institutional rigidity” and “practical flexibility” in China’s tennis referee management, that is, unified national standards are often deformed due to resource constraints when implemented locally [8]. These studies suggest that Guangxi, as a post-development region, may face a dual dilemma in its training and management mechanism: it must catch up with standardization and adapt to practical adaptations under resource constraints.

The complexity and situational cognition of the factors affecting the effectiveness of adjudication

Beyond systems and skills, research has paid more and more attention to the “human” factor in recent years. Araújo et al. found that the refereeing effectiveness of high-level referees is affected by a complex interaction of factors such as individual characteristics (e.g., professional identity, learning ability), organizational environment (e.g., training quality, peer support), and event context (e.g., spectator pressure, event level). This finding aligns with cognitive-ecological models in sports psychology [9]. Cunningham et al. further extracted six competency characteristics of excellent tennis referees through behavioral event interviews, among which “cultural intelligence” and “adaptive communication ability” are particularly noteworthy [10]. This provides a key conceptual tool for this study to analyze the performance of Guangxi referees in the multi-ethnic cultural environment and foreign-related exchange scenarios. Aksu specifically pointed out that mental toughness training should become the core link of referee training. This view has been confirmed in the pre-survey of this study. Guangxi referees generally report that the pressure of “acquaintance society” in amateur competitions is a unique psychological challenge [11]. Additionally, studies comparing expert and novice referees have shown significant differences in visual search behavior and decision-making accuracy,

highlighting the importance of experiential learning [12].

Theoretical framework

To provide a robust theoretical grounding for analyzing the developmental predicament of tennis referees in Guangxi, this study integrates three complementary theoretical perspectives: Regional Sports Talent Supply-Demand Adaptation Theory, Social Closure Theory, and Cultural Intelligence Theory. The Regional Sports Talent Supply-Demand Adaptation Theory serves as the macro-level lens, positing that the effectiveness of a talent cultivation system relies on the dynamic equilibrium between the “supply” of training outcomes and the “demand” of regional strategic needs. This framework facilitates the diagnosis of the structural misalignment between the current standardized training model and Guangxi’s distinctive ASEAN-oriented and multi-ethnic contextual demands. Complementing this macro analytical lens, Social Closure Theory offers a meso-level structural account of the career development barriers faced by local referees. It elucidates how dominant insider groups entrench their positional advantages by monopolizing promotion channels and high-quality officiating opportunities, thereby erecting a “glass ceiling” that impedes the vertical mobility of emerging young referees. Finally, Cultural Intelligence Theory offers a micro-level competency metric, emphasizing the individual’s ability to function effectively in culturally diverse settings - a critical yet overlooked capacity necessary for navigating both international ASEAN exchanges and local multi-ethnic interactions. These three theories are logically interconnected: The Supply-demand mismatch reveals the systemic symptoms, social closure explains the institutional inertia exacerbating this stagnation, and cultural intelligence identifies the specific competency gaps required for system modernization.

In summary, the existing research has established a relatively complete analytical framework, but there are two significant gaps: First, the fault of regional research, the existing achievements are highly concentrated in the eastern developed provinces, and the development logic of the latter may be completely different. Second, the lack of “supply-demand” linkage, most studies start from the “supply side” (how to cultivate referees), but less systematically examine the specificity of the “demand

side”.

Methodology

In order to systematically explore the training status and deep constraints of tennis referees in Guangxi, this study adopts a mixed research method and is carried out in stages. Firstly, a large-scale scan was conducted through quantitative questionnaires to understand the structural characteristics, training participation and general cognition of the referee team. Subsequently, in-depth interviews were conducted on the key issues and typical groups that emerged in the quantitative analysis to obtain a more contextual and procedural understanding. This “from surface to point” design aims to confirm the macro status quo and micro experience, and together constitute a three-dimensional presentation of the research problem. The research subjects cover registered tennis referees in Guangxi. In the quantitative stage, relying on the official channels of the Guangxi Tennis Association, a hierarchical sampling questionnaire survey was conducted on referees at all levels, and finally 147 valid questionnaires were collected, of which the proportion of national, first, second, and third level referees was basically in line with the distribution structure of referees in the whole region, ensuring the representativeness of the sample.

To ensure the structural representativeness of the quantitative data, this study adopted a stratified random sampling strategy based on the registered referee population in the Guangxi Tennis Association. The sampling frame was stratified along the dimension of Referee Technical Grade, which represents the core professional hierarchy within the Chinese sports system. The sample size for each stratum was determined using proportional allocation, strictly aligning with the actual pyramidal distribution of tennis referees in the Guangxi region (N=147). The specific stratification and sampling proportions were as follows:

Elite and backbone tier (national level & level 1): This stratum comprised 21.8% of the total sample (N=32, including 4 national and 28 level 1 referees). It was sampled to capture expert perspectives on high-level enforcement and rule interpretation.

Grassroots foundation tier (level 2 & level 3): This stratum constituted the majority, accounting for 78.2% of the sample (N=115, including 65 Level 2 and 50 Level 3

referees). This proportion reflects the broad base of referees who form the foundation of the regional officiating system.

By maintaining consistency with the regional population distribution, this design minimizes sampling bias and

ensures that the identified constraints, such as the “glass ceiling” in promotion - are statistically representative of the entire refereeing community in Guangxi. The detailed demographic characteristics of the sample are presented in Table 1.

Table 1. Demographic characteristics of the survey sample (N=147).

Variable	Category	Frequency (N)	Percentage (%)
Gender	Male	98	66.7
	Female	49	33.3
Age	Under 35 years	92	62.6
	35 years and above	55	37.4
Education	Undergraduate or below	122	83.0
	Master's degree or higher	25	17.0
Referee level	National level	4	2.8
	Level 1	28	19.0
	Level 2	65	44.2
	Level 3	50	34.0
Refereeing experience	1-3 years	60	40.8
	4-9 years	55	37.4
	10 years and above	32	21.8

At the qualitative research stage, we adopted a purposive sampling strategy to select eight key informants for the study. These participants included tennis association administrators, senior training instructors, referees with foreign-related officiating experience, core referees from ethnic minority regions, and young referee representatives. In-depth, semi-structured interviews were conducted with all selected informants to elicit authentic, multi-perspectival insights into the research context.

In terms of research tools, the questionnaire design fully draws on the existing mature scales and localizes them in combination with the actual situation in Guangxi, covering four modules: personal background, training experience, professional environment perception and ability development needs. The interviews adopted a semi-structured outline, focusing on the logic of “personal growth process-perception of realistic challenges-development path prospects”, encouraging interviewees to tell specific stories and share real confusion. The entire research process strictly adheres to academic ethics and focuses on protecting the privacy of respondents, while we are also aware of the limitations of cross-sectional research in causal inference, as well as the fact that the sampling may not fully cover referees in

marginal areas, which will be explained in subsequent discussions. The entire research process strictly adheres to academic ethics and focuses on protecting the privacy of respondents, with all identifying information of participants anonymized in data transcription and analysis. All research protocols were reviewed and approved by the institutional research ethics committee, in line with the ethical guidelines for social science research in sports. While we are also aware of the limitations of cross-sectional research in causal inference, as well as the fact that the sampling may not fully cover referees in marginal areas, which will be explained in subsequent discussions.

Results

Participation and structural characteristics of the training system

Through the study, we know that the training activities of tennis referees in Guangxi have achieved basic coverage, but show the characteristics of “high frequency, shallow level” (as shown in Table 2). About 86.3% of respondents attended at least one official training in the past year, with an average annual participation of 1.7 times. However, the training content is highly concentrated on “interpretation of annual rule changes” (92.5%) and

“review of basic enforcement procedures” (88.4%), and the coverage rate of advanced and targeted modules such as “electronic playback system (eagle eye) operation simulation”, “event risk management and emergency plan” and “psychological resilience training” is less than 25.0%. Large-scale theoretical teaching is the main form of training (accounting for 94.2%), while practical

workshops such as small-class workshops, scenario simulation and high-level competitions are seriously missing [13]. A senior trainer bluntly said in an interview: “Our current training is more like an ‘annual notice’ telling the referee where the rules have changed this year, but how to use the rules well, deal with complex situations, practice too little.”

Table 2. Status of training participation and content structure.

Category	Indicator / Item	Statistic
Participation frequency	Attended at least one official training (Past Year)	86.3%
	Average annual training frequency	1.7 times
Training content	Interpretation of annual rule changes	92.5%
	Review of basic enforcement procedures	88.4%
	Advanced modules (e.g., Hawk-Eye, Psych. Resilience)	<25.0%
Training format	Large-scale theoretical teaching	94.2%
	Practical workshops / Scenario simulation	5.8%

In terms of assessment and promotion mechanism, the data show an obvious “glass ceiling” effect in Table 3. More than 90.0% of referees acknowledge the necessity of theoretical assessment in the promotion process. However, 78.6% of respondents indicate that promotion outcomes are not entirely determined by open and transparent competency evaluations. Instead, they are significantly influenced by non-standardized factors, such as the distribution of officiating opportunities and familiarity with relevant associations. This resulted in a particularly congested pathway for the promotion from level 2 to level 1, with an average waiting period of 4.3 years and significant regional imbalances. This uneven promotion landscape further undermines the motivation of grassroots referees to pursue professional development and upgrade their officiating competencies.

Occupational environment perception and core constraints

Referees were at a moderate-low level of satisfaction with the professional environment (mean 2.8 / 5.0). The most prominent contradiction is reflected in the “scarcity and uneven distribution of adjudication opportunities”.

More than 80.0% of referees at level 1 and below said that the opportunity to referee high-level and high-standard events in the region (such as ITF tours, national junior ranking tournaments) is almost monopolized by a small number of fixed national referees. A young referee described: “In some corporate competitions, there are not even basic referee chairs and parasols, and the scoresheet has to be prepared by yourself. We feel more like temporary ‘order keepers’ than professional judges.”

The downturn in economic remuneration and professional identity forms a vicious circle. The average daily allowance for event referees in Guangxi is generally in the range of 200-400 yuan, and it is often in arrears. After calculating the cost of transportation and time, the referee income is not attractive to part-time referees. More importantly, the immaterial incentive system is almost blank. 87.1% of the respondents said that they had never received any form of recognition, further education or priority recommendation opportunities due to their excellent executive performance, resulting in a serious lack of professional honor.

Table 3. Referees’ perception of career constraints and environment (N=147).

Dimension	Key findings	Proportion / Value
Promotion mechanism	Perception of “glass ceiling” (opacity in promotion)	78.6%
	Average waiting period (level 2 to level 1)	4.3 years
Incentive system	Never received any recognition or priority recommendation	87.1%

Dimension	Key findings	Proportion / Value
	Satisfaction with professional environment (mean)	2.8 / 5.0
Competency gaps	Ability to cope with English/Foreign-related refereeing	<8.0%
Age-related needs	>35 years old: prioritize system transparency	75.4%
	<35 years old: prioritize systematic empowerment	81.2%

Note: 2.8 / 5.0 means that the average score of satisfaction with the professional environment is 2.8 (out of 5.0).

The emergence of regional specificity challenges

The interview data profoundly reveals two challenges with Guangxi characteristics, which are difficult to fully capture with quantitative data.

First of all, there is a sharp contradiction between the location advantage of “facing ASEAN” and the shortcomings of referees’ “foreign-related ability”. With the increase of China-ASEAN tennis exchange tournaments, border city invitational tournaments and other activities, there is an urgent need for referees with basic English communication skills and understanding of the sports culture of ASEAN countries. However, less than 8% of the referees in the survey said they could barely cope with simple English refereeing, and the relevant training was almost blank. A referee who has had a foreign-related event as an assistant referee said frankly: “At that time, the players on the field were from Thailand and Vietnam, and when there was a dispute, I couldn’t effectively communicate and explain the basis of the penalty except to say ‘calm down’ and gesture, and finally I could only urgently invite a translator, which was very embarrassing.”

Secondly, the communication in the arena in the context of multi-ethnic culture presents special complexity. In events held in ethnic minority areas such as Baise and Hechi, referees need to deal with special disputes caused by differences in language habits and cultural understanding. For example, a local Zhuang referee shared: “Some elderly players will express strong emotions in dialect when arguing, and if you don’t understand and simply warn according to the rules, it may be misunderstood as disrespectful and intensify the conflict.” This requires referees not only to understand the rules, but also to understand a little bit of the human world. This “local knowledge” is currently completely outside the standardized training system.

Intergenerational differences in development demands

The data analysis also reveals the differentiation of the

development demands of referees of different ages. Senior referees over the age of 35 pay more attention to “transparency and fairness of the system” (accounting for 75.4%) and are eager for a clear promotion path and stable opportunities to participate in high-level events. Young referees under the age of 35 exhibit a strong desire for systematic empowerment, with this group accounting for 81.2% of respondents expressing such a demand. Beyond mastering fundamental officiating rules, they have an urgent need to acquire modern refereeing competencies, including psychological stress resilience, conflict management, and the application of event-related technologies. They also anticipate accessing sustained learning resources through more flexible modalities, such as online professional communities and curated case libraries. This difference reflects the higher expectations of the new generation of referees for professional and professional development.

To sum up, the current situation of the training of tennis referees in Guangxi is presented as follows: A training network with extensive coverage but insufficient depth, a set of promotion mechanisms with “invisible thresholds”, a professional environment that lacks incentives and recognition, and two regional special challenges that need to be responded to urgently. These findings point to the urgency of system upgrading and model innovation.

Discussion

The results of this study reveal a core paradox: In the context of the continuous rise in the popularity of tennis participation, the professional development of tennis referees in Guangxi has fallen into a state of “systematic delay” [14]. This lag is not simply caused by a lack of resources, but more profoundly reflects the structural mismatch between the standardized training model and regional actual needs, as well as the internal tension between traditional management thinking and modern professional development demands.

From “rule transmission” to “capacity building”: The dilemma of paradigm transformation of the training system

The current referee training system in Guangxi is still essentially a model centered on “rule transmission”. Its design logic presupposes that “as long as the rules and provisions are accurately grasped, effective adjudication can be achieved”. This may be effective in the early days of frequent rule changes, but when the referee team basically realizes the popularization of the rules, the marginal benefits of training decrease sharply. The data of this study shows that referees have developed “cognitive fatigue” in the training of “rule change interpretation”, and the real challenge they face has shifted from “knowing the rules” to “how to apply the rules in complex, high-pressure and changeable field situations”. This echoes the conclusion of research on “expert performance” in sports cognitive science: The difference between experts and novices is not the amount of knowledge, but the ability to effectively recognize patterns and adaptive decisions in dynamic environments [15]. The lack of modules such as “psychological training”, “in-depth case discussion” and “simulated situational decision-making” in the Guangxi training system is a concentrated embodiment of the failure to complete the transformation from the paradigm of “knowledge transfer” to the paradigm of “ability building”. The direct consequence of this lag is that referees may be “top students” in book assessments, but they may become “helpless adjudicators” in real arenas.

The double closure of career development channels

The influence of non-standardized factors in the promotion mechanism and the high concentration of high-level refereeing opportunities together constitute the “glass ceiling” of referee career development. This phenomenon can be interpreted by borrowing the theory of “social closure” in sociology. Dominant groups (such as referees who have obtained high-level certifications and have close ties with the association) invisibly set up barriers by controlling key resources (high-level event refereeing opportunities) and limit the upside of latecomers. This not only causes a waste of talent, but also erodes the credibility of the system. At the same time, the “part-time” status of the vast majority of referees has long been in the ambiguous area between “amateurs” and “professional adjudicators”. This ambiguity of identity

makes it difficult for them to form a strong sense of professional identity and professional community. They are unable to obtain stable income and career planning like professional referees, and they are subjected to higher expectations and pressure than ordinary enthusiasts because they invest a lot of spare time. This structural dilemma makes it difficult for the referee team to attract and retain the most promising young talents, falling into a low-level cycle.

Capacity shortcomings under location advantages:

The rupture of regional characteristic demand and generalized supply

Guangxi’s “ASEAN-oriented” location advantage should be a unique strategic resource for the development of its sports talents. However, this study found that this advantage reflects the biggest shortcoming of the current training system. In the context of global sports, referees are not only the enforcers of rules, but also the interface of cross-cultural communication and the practitioner of sports diplomacy. Foreign-related adjudication capabilities require a blend of language skills, cross-cultural understanding, and awareness of international rules and conventions [16]. The current training system in Guangxi is almost unaware of this, and is still limited to the common Putonghua teaching and domestic competition cases, creating a huge gap between “strategic opportunities” and “tactical preparation”. Similarly, the neglect of the particularity of communication in the field under the background of multi-ethnic culture also reflects the arrogance of standardized management thinking on local knowledge. Simply classifying the emotional expressions of minority players in controversy as “interfering with the game” rather than trying to understand their cultural context can lead to the mechanics of refereeing and the escalation of conflict. This “rupture” shows that the existing cultivation system is a “decontextualized” abstract design, which fails to embed and respond to the specific social and cultural soil of Guangxi.

Differentiation of intergenerational demands: Reveal the internal driving force of system change

The strong demand of young referees for “systematic empowerment” and “flexible learning” is a valuable endogenous driving force for system change. This generation has grown up in the digital age, accustomed to acquiring knowledge on demand and learning

interactively in communities. They are not content with being passive rule recipients but aspire to be professionals who can proactively address complex challenges. Their attention to “psychological capital” and “technology application” is pointing to the core dimension of future referee specialization. The rigid, one-way, and low-frequency training model in the existing system has a deep contradiction with their study habits and career expectations. Ignoring this generational difference will lead to the alienation and loss of the new generation of referees. On the contrary, if their demands can be transformed into specific entry points for reform (such as building an online case sharing platform, developing VR-based situational training modules, and establishing a mentor system), it may find a breakthrough in cracking the “lag” state of the system.

To sum up, the challenges faced by the training of tennis referees in Guangxi are a typical “developing problem”. It indicates that when tennis moves from initial popularization to a new stage of quality improvement, the supporting professional talent support system must also undergo synchronous and profound paradigm reconstruction.

Conclusion

This study reveals that the training system of Guangxi tennis referees is facing profound transformation challenges while achieving basic coverage: Its traditional training paradigm with rule transmission as the core has been difficult to meet the practical needs of referees in complex arena situations. It implies a promotion mechanism with non-standardized barriers and a professional environment with insufficient incentives, forming a “glass ceiling” that restricts professional development. Notably, vigilance is warranted regarding the cultivation system’s lack of a strategic response to two critical regional needs: The foreign-related officiating competencies essential to leveraging Guangxi’s ASEAN-oriented geographical advantages, and the unique communication considerations inherent to its multi-ethnic cultural context. This oversight has created a profound disconnect between the region’s strategic development opportunities and the tactical talent development preparations required to capitalize on them. Therefore, the key to advancing the development of Guangxi’s tennis referee cohort lies in achieving a systemic paradigm shift from generic knowledge

transmission to contextually embedded competency cultivation. It also entails constructing an adaptive development ecosystem that deeply integrates regional characteristics, galvanizes intergenerational innovation momentum, and offers a clear and structured career advancement pathway for referees at all levels.

The conclusions of this study need to be carefully understood in the following limitations: First, due to the influence of sampling channels, although the sample covers judges at all levels, it may not be represented enough for “inactive” judges in remote areas and completely out of the management of the association. Secondly, although the cross-sectional design reveals structural problems, it cannot confirm the causal relationship and dynamic evolution process between various factors. Finally, the study is mainly based on the self-report of referees and managers, and lacks direct observation of refereeing behavior and multi-dimensional data verification by stakeholders such as athletes and coaches, and there may be common methodological biases.

Future research can be in-depth from three dimensions: In terms of methodology, a longitudinal tracking design can be used to continuously monitor the growth trajectory of referees’ abilities and their correlation with key events (such as specific training, refereeing of important events). From the perspective, multiple evaluations such as athletes and event organizers should be included to construct a multi-source evaluation triangle for referee performance. In terms of research content, targeted intervention studies are warranted to address the identified competency gaps. For instance, this could involve designing specialized training curricula for referees officiating ASEAN-related events and empirically evaluating the effectiveness of such programs. Additionally, comparative research can be conducted between Guangxi and Yunnan - two provinces with analogous geographical and demographic characteristics - to explore the shared pathways and differentiated strategies for cultivating sports professionals in border multi-ethnic regions.

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Conflict of Interest

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