

## **Perceptions of the role, value and barriers of sports scientists in Australia among practitioners, employers and coaches**

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### **ARTICLE INFO**

*Received: 12.03.2021*

*Accepted: 17.08.2021*

*Online: 20.09.2021*

#### **Keywords:**

*Sports science practitioner*

*Sports scientist*

*Coaching*

*Employment*

*High-performance sport*

### **ABSTRACT**

*Sports scientists in Australia are experiencing unpaid internships, long work hours and job insecurity, and previous research has indicated that coaches have ranked sports scientists as an unlikely source for them to seek new information. These factors suggest some employers and coaches do not value sports scientists. The current preliminary study compared the perceptions of sports scientists in Australian sport between those working as sports science practitioners, their employers and coaches. Australian sports science practitioners (n = 36), current/potential employers for sports scientists (n = 20) and sports coaches (n = 10) completed an online questionnaire. The questionnaire contained items that identified perceptions of the primary role, tasks, value, effectiveness and barriers of sports science practitioners. The most commonly reported tasks of a sports scientist were 'assessments of fitness/performance', 'performance analysis' and 'training monitoring' for practitioners, employers and coaches, respectively. Coaches ranked sports scientists as the practitioner role offering the least value to an athlete (rank = 8/8), while the practitioners (rank = 3/8) and employers (rank = 2/8) ranked sports scientists as one of the most valuable. All groups 'agreed' or 'strongly agreed' that sports scientists have a necessary role in sport and are effective in improving an athlete's performance. For those in the sports team setting, employers 'somewhat agreed' that sports scientists receive fair working conditions while the practitioners 'somewhat disagreed' (p = 0.040). There are discrepancies in the perceptions of sports scientists between practitioners, employers and coaches in Australia. By addressing these discrepancies, it may be possible to improve the perceived and actual value of sports science practitioners and their working conditions.*

## **1. Introduction**

Sports science education commenced in Australia at the University of Western Australia in 1968, and the first sports science practitioners in Australia were hired at the Australian Institute of Sport in 1981 (Bloomfield, 2002). From this time until 2013, the Australian Institute of Sport became a world leader in sports science servicing and research (Blood, 2018), and Australian sports science practitioners subsequently became highly sought after internationally. The national accrediting body for sports scientists in Australia (Exercise & Sports Science Australia; ESSA) define accredited sports scientists as 'specialists in the application of scientific principles and techniques to assist coaches and athletes improve their performance at an individual level or within the context of a team environment' (Exercise &

Sports Science Australia, 2020). Exercise & Sports Science Australia has also published a scope of practice for sports scientists, which included the assessment and application of theoretical knowledge and scientific principles to maximise performance, along with responsibilities surrounding the sporting environment, the athlete's needs, and policy (Exercise & Sports Science Australia, 2020). The definition and scope of practice were developed in response to a 2013 Australian Senate enquiry that determined a lack of regulation within the sports science profession (Greenhow, 2013), and subsequent regulation has led to 351 sports scientists becoming accredited with ESSA as of December, 2020 (communication with Exercise & Sports Science Australia).

A national profile of the sports science workforce has demonstrated the continuing complexity of the sports science

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industry, with many specialised roles and tasks that exist within the umbrella term 'sports scientist' (Dwyer, Bellesini, Gastin, Kremer, & Dawson, 2019). Originally, sports scientists were tasked with research, development and innovation, coach and peer education, mentoring, technology evaluation and implementation, more recently, however, roles have had a greater focus on 'service delivery'. The nature of these roles is captured by the sports science disciplines that have been categorised by ESSA; performance analysis, skills acquisition, sports biomechanics, sports physiology and strength science (Exercise & Sports Science Australia, 2020). However, debate exists as to whether a sports science practitioner should operate as a specialist in one discipline, or as a generalist across multiple disciplines (McCunn, 2019). The specific day-to-day tasks of a sports science practitioner are not well-described within original research, but a range of tasks are documented, including research and knowledge translation to increase evidence-based practice (Bartlett & Drust, 2020; Fullagar, McCall, Impellizzeri, Favero, & Coutts, 2019); interpretation of complex data, intervention development, testing and training prescription (Thompson, 2010b); optimising training/learning design and individualising training/learning programs (Renshaw, Davids, & Savelsbergh, 2010); technique enhancement and injury prevention (Elliott & Bartlett, 2006); and, most recently, critical evaluation of technology (Sandbakk, 2020).

With no award wage for sports science practitioners in Australia, many sports scientists receive pay rates independently determined by their employer's perception of value, organisational resources and available funding (Dwyer et al., 2019). Hence, their ability to work and be paid relevant to their expertise is somewhat reliant on their employers' perception of them and their impact. Upon graduation, many aspiring sports scientists are required to undertake an unpaid internship to gain experience, as an undergraduate degree is not necessarily considered to be worthy of paid employment in the industry (Doncaster, 2018; York, Gastin, & Dawson, 2014). Challenges for Australian sports scientists also continue after employment, including long work hours and job insecurity (Dwyer et al., 2019). Sports scientists are often required to work ten or more hours per week above their contract, and, just four out of ten positions are permanent (Dwyer et al., 2019). Sports science practitioners are also known to receive poor recognition for their work and have little opportunity for career advancement (York et al., 2014). Their working environment has also been described as 'volatile' given the pressure for competition success and the rapid change that can occur with coaching staff and funding at sports organisations (Thompson, 2010a; Wagstaff, Gilmore, & Thelwell, 2015). As such, longevity in sports science roles is poor, which is evident from practitioners having a lower age and a low number of years in their current position (Dwyer et al., 2019).

In a sports organisation, the sports scientist often reports to the head coach (either formally or informally), and as such, coach perceptions of sports science practitioners are crucial for sports science employment. Coaches have identified some struggles engaging with sports science practitioners, such as problems with integration into the applied setting and poor understanding of the needs of a specific sport, as well as the overuse of jargon (Martindale & Nash, 2013). Coaches have also described barriers to sports science research application, including funding, time, 'buy-in' and low practical relevance of research aims (Fullagar et al., 2019), while qualities such as excellent knowledge of the sport, JSES | <https://doi.org/10.36905/jses.2021.04.07>

experience and communication skills, make coaches more likely to engage with sports science practitioners (Schwarz et al., 2021). Some sports science practitioners working in the biomechanics setting have explained a dysfunctional relationship with coaches, potentially resulting from the practitioners having poor communication skills, and the coaches having a poor understanding of the discipline and the services that the practitioners can offer (Waters, Phillips, Panchuk, & Dawson, 2019). Similar challenges exist in the skills acquisition setting, where building trust with a coach is a long and challenging process for a sports scientist, and sometimes only achieved after they have delivered results (Dehghansai, Headrick, Renshaw, Pinder, & Barris, 2020). As such, coaches have ranked sports scientists (and their research) as a very unlikely source for them to seek new information (Reade, Rodgers, & Hall, 2008). These barriers, combined with sports science employment that is characterised by unpaid internships, high workload and a lack of job security, suggest that some employers and coaches may place low value in sports science practitioners, however, this has not been investigated.

Therefore, our focus was to determine the perceptions of sports science practitioners in Australia. More specifically, this preliminary study will compare the perceptions of the primary role, tasks, value and barriers of sports science practitioners between their employers, coaches and the sports science practitioners themselves. By addressing these aims, we will determine any differences in understanding that can be addressed and potentially improved for the profession. Since there is information available on the career experiences of sports scientists (Dawson et al., 2013; Dwyer et al., 2019; York et al., 2014), we explored reasons for these experiences from the perspectives of key stakeholders. We envisage that the findings following on from this preliminary study can guide a more extensive study toward key areas of differentiation identified in the current study.

## 2. Methods

### 2.1 Design

An online questionnaire was developed (Qualtrics Core XM, Provo, Utah, USA) to measure participants' perceptions of the primary role, value and barriers of sports science practitioners. The survey had mixed response types with different questions suited to quantitative (e.g., likert scale) and qualitative analysis (open text). This design is based on similar studies on related professions including sports psychology (Johnson, Andersson, & Fallby, 2011; Pain & Harwood, 2004; Zakrajsek, Martin, & Wisberg, 2016) and physiotherapy (Lee & Sheppard, 1998; Puckree, Harinarain, Ramdath, Singh, & Ras, 2011). The study was approved by the Southern Cross University Human Research Ethics Committee in the spirit of the Helsinki Declaration and the participants provided written, informed consent before commencing the questionnaire.

### 2.2 Participants

The questionnaire was completed by 66 participants recruited from three populations, including; i) sports science practitioners

(n = 36); ii) employers with hiring responsibilities of sports science practitioners (n = 20), and; iii) sports coaches (n = 10). Sports coaches were included as an additional group due to their advocacy role in sports science employment. Inclusion criteria stipulated that participants must have been currently working in Australia and aged over 18 years. Potential participants were contacted via email (where contact details were available online) with an invitation to complete the questionnaire. Snowball sampling (Biernacki & Waldorf, 1981) further increased recruitment as this sample is difficult to reach. Screening questions were used to ensure that each participant was from one of the populations of interest and met the inclusion criteria. The demographics of each group, including level and setting of work, are presented in Table 1. Typically, use the following subheadings: Participants, Apparatus, Task, Procedure, and Statistical Approach. Include a statement regarding consent to participate and a statement of institutional or organisational ethical approval.

### 2.3 Procedures

The questionnaire contained 23 items, as detailed in Appendix 1. Seven items were used for screening and the collection of demographic information. Ten items delved into the participants' perceptions, including knowledge and attitudes toward sports scientists. The remaining questions explored the barriers to employment and working conditions for sports scientists. As part of a pilot study, ten volunteers (8 practitioners and 2 employers; 5 male and 5 female) completed the questionnaire to check clarity, comprehension, timing, and understanding of the questionnaire. This procedure enabled the researchers to amend the wording of some questions and insert an additional question about sports science disciplines. This pilot also allowed the development of a list of tasks performed by sports scientists for one of the items. Following the pilot, it was determined that the questionnaire was

appropriate and had face validity. The questionnaire was open between June-July, 2019.

### 2.4 Statistical Analysis

Frequency distributions were calculated where necessary and rank order responses were assigned numerical values (i.e., 8 for highest, 1 for lowest etc.) that were summed to determine the mean rank order (i.e., highest total score equals highest rank). The level of agreement to quantitative statements was determined via 7-point Likert scale (where 1 = strongly disagree, 7 = strongly agree) and presented as median ± interquartile range (ICR). Data from each questionnaire item were analysed via a Kruskal-Wallis H Test and pairwise comparisons where significant differences were observed, with alpha set at <0.05 (SPSS Statistics, 2012). All Likert scale distributions were similar for all groups within each item, as assessed by visual inspection of a boxplot. The qualitative data were interpreted using principles of thematic analysis (Clarke, 2015) by clustering answers around underlying uniformities from which key ideas emerged. Upon examining the data, themes were observed and grouped together and then labelled by two researchers separately. Any differences in this labelling were discussed before reaching an agreement. Quotes were also extracted from the data and presented without editing.

## 3. Results

Participants were asked 'In your role or context, what is (or would be) the main role of a sports scientist' and 'what are the main tasks of a sports scientist'. The responses are summarised in Figure 1 and Table 2, respectively. The results of the participants ranking different sports practitioner and sports science disciplines in order of their value and priority are summarised in Table 3.

Table 1: Group demographics.

Group	Age (y)	Female (%)	Level (%)	Setting (%) <sup>2</sup>
Practitioners (n = 36)	34.3 ± 9.9	42	Professional = 50 National = 42 State = 6 Local = 3	Sports team = 31 Institute/Academy = 50 NSO = 31 University = 25
Employers <sup>1</sup> (n = 20)	45.4 ± 10.8	25	Professional = 20 National = 40 State = 30 Local = 10	Sports team = 35 Institute/Academy = 25 NSO = 40 SSO = 15
Coaches (n = 10)	45.8 ± 8.0	20	Professional = 30 National = 40 State = 30	Sports team = 50 Institute/Academy = 50 NSO = 50 Consultant = 10

Note: <sup>1</sup>Employers included high performance managers (n = 11) and sports executives/administrators (n = 9). <sup>2</sup>Multiple settings could be selected (NSO=National Sporting Organisation, SSO=State Sporting Organisation)

Table 2: Most common selections between groups in response to item ‘In your role or context, what are the main tasks of a sports scientist’.

Tasks	Practitioners		Employers		Coaches	
	#	%	#	%	#	%
Assessments of fitness/performance	20	56*	9	45	7	70
Training monitoring	19	53	10	52	8	80*
Designing, implementing and modifying training programs	15	42	4	20	4	40
Research	15	42	3	15	4	40
Recovery	12	33	9	45	6	60
Recording performance in training and competition	12	33	7	35	4	40
Performance analysis	11	31	11	55*	7	70
Athlete education	11	31	5	25	5	50
Implementing interventions	10	28	3	15	4	40
Assessments of technique/skill	9	25	3	15	2	20
Technique development	9	25	3	15	2	20
Injury prevention	7	19	5	25	4	40
Injury rehabilitation	6	17	6	30	5	50
Aggregating and curating records	4	11	4	20	1	10
Goal setting	3	8	2	10	3	30

Note: \*Represents most common response

For the statement ‘A sports scientist is effective in improving an athlete’s performance’ practitioners responded ‘strongly agree’ (median ± IQR; 7.0 ± 1.0), employers responded ‘strongly agree’ (7.0 ± 1.0) and coaches responded ‘agree’ (6.0 ± 1.5), with no significant differences between groups,  $H(2) = 3.655, p = 0.161$ . For the statement ‘Sports scientists have a necessary role in sport today,’ practitioners responded ‘strongly agree’ (7.0 ± 0.3), employers responded ‘agree’ (6.0 ± 1.0) and coaches responded ‘strongly agree’ (7.0 ± 0.8), with no significant differences between groups,  $H(2) = 3.880, p = 0.144$ . For this question, participants could explain their answer, and the responses are

presented in the supporting information. For the statement ‘In an ideal situation, with no barriers, I would employ a sports scientist (or more sports scientists) to support my athlete/team,’ practitioners responded ‘strongly agree’ (7.0 ± 1.0), employers responded ‘strongly agree’ (7.0 ± 1.0) and coaches responded ‘agree’ (6.0 ± 1.75), with no significant differences between groups,  $H(2) = 2.388, p = 0.303$ . For this question, participants could explain their answer, and the responses are presented in the supporting information.

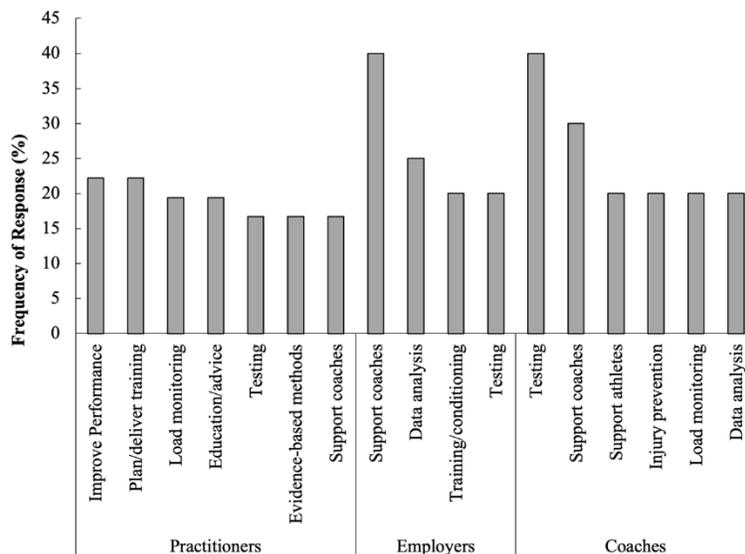


Figure 1: Most common themes between groups in response to item ‘In your role or context, what is (or would be) the main role of a sports scientist’.

Table 3: Rank order responses by group for items ‘In your role or context, rank the following practitioners in order of their value to an athlete’ and ‘In your role or context, rank the following sports science disciplines in order of their priority’.

	<b>Rank order of practitioners in order of their value to an athlete (score)</b>	<b>Rank order of sports science disciplines in order of their priority (score)</b>
Practitioners	<ol style="list-style-type: none"> <li>1. Coach (278)</li> <li>2. Strength and conditioning (181)</li> <li>3. Sports scientist (168)</li> <li>4. Sports psychologist (155)</li> <li>5. Sports physician/medic (149)</li> <li>6. Dietitian/nutritionist (148)</li> <li>7. Physiotherapist (135)</li> <li>8. High performance manager (98)</li> </ol>	<ol style="list-style-type: none"> <li>1. Sports physiology (127)</li> <li>2. Strength and conditioning (123)</li> <li>3. Performance analysis (104)</li> <li>4. Motor control and skill acquisition (94)</li> <li>5. Sports biomechanics (93)</li> </ol>
Employers	<ol style="list-style-type: none"> <li>1. Coach (144)</li> <li>2. Sports scientist (98)</li> <li>3. Strength and conditioning (92)</li> <li>4. Sports physician/medic (92)</li> <li>5. Sports psychologist (85)</li> <li>6. High performance manager (79)</li> <li>7. Physiotherapist (73)</li> <li>8. Dietitian/nutritionist (57)</li> </ol>	<ol style="list-style-type: none"> <li>1. Motor control and skill acquisition (70)</li> <li>2. Sports physiology (60)</li> <li>3. Strength and conditioning (59)</li> <li>4. Sports biomechanics (56)</li> <li>5. Performance analysis (55)</li> </ol>
Coaches	<ol style="list-style-type: none"> <li>1. Coach (79)</li> <li>2. Physiotherapist (47)</li> <li>3. Sports psychologist (45)</li> <li>4. High performance manager (42)</li> <li>5. Strength and conditioning (39)</li> <li>6. Sports physician/medic (38)</li> <li>7. Dietitian/nutritionist (36)</li> <li>8. Sports scientist (34)</li> </ol>	<ol style="list-style-type: none"> <li>1. Motor control and skill acquisition (34)</li> <li>2. Sports biomechanics (30)</li> <li>3. Sports physiology (29)</li> <li>4. Strength and conditioning (29)</li> <li>5. Performance analysis (28)</li> </ol>

Note: ‘Score’ represents the sum of responses to the 7-point Likert scale.

When asked ‘What are the most important barriers preventing the employment of a sports scientist,’ practitioners responded with ‘lack of opportunities/a large number of graduates’ (52.8%, n = 19) and ‘lack of practical applications, experience or knowledge’ (30.6%, n = 11). Employers responded with ‘finance’ (75%, n = 15) and ‘lack of practical applications, experience or knowledge’ (20%, n = 4). Coaches responded with ‘finance’ (70%, n=7), personality/communication issues (20%, n = 2) and ‘lack of practical applications, experience or knowledge’ (20%, n = 2).

For the statement ‘Sports scientists generally receive fair working conditions’ practitioners responded ‘somewhat agree’ (5.0 ± 1.5), employers responded ‘somewhat agree’ (5.0 ± 2.0), and coaches responded ‘somewhat agree’ (5.0 ± 2.0), with no significant differences between groups, H(2) = 1.356, p = 0.508. Since there was a lower agreement for this item, further comparisons were made after practitioners and employers were broken into groups based on their work setting. For those in the sports team setting, practitioners responded ‘somewhat disagree’ (n = 11, 3.0 ± 2.0), employers responded ‘somewhat agree’ (n = 7; 5.0 ± 2.5) and coaches responded ‘neither agree nor disagree’ (n = 5, 4.0 ± 2.0), with significant differences between groups, H(2) = 6.497, p = 0.039, and specifically, a significant difference between practitioners and employers (p = 0.040).

For those in the institute/academy setting, practitioners responded ‘somewhat agree’ (n = 18, 5.0 ± 1.0), employers responded ‘somewhat agree’ (n = 5, 5.0 ± 0.0) and coaches responded ‘neither agree nor disagree’ (n = 5, 4.0 ± 2.0), with no significant differences between groups, H(2) = 4.453, p = 0.108. For those in the national sporting organisation setting, practitioners responded ‘somewhat agree’ (n = 12, 5.0 ± 1.0), employers responded ‘somewhat agree’ (n = 8, 4.5 ± 1.8) and coaches responded ‘agree’ (n = 5, 6.0 ± 3.0), with no significant differences between groups, H(2) = 1.082, p = 0.582. Other work settings were not included in this analysis due to having less than 5 participants in some groups.

#### 4. Discussion

This preliminary study aimed to conduct a novel comparison between sports science practitioners, employers and coaches in their perceptions of sports scientists. Differences were identified in the primary role and tasks of sports scientists, and coaches ranked sports scientists as the practitioner with the least value for an athlete out of eight practitioner roles in the sport setting. However, sports scientists, employers and coaches all ‘agreed’ or ‘strongly agreed’ that sports scientists have a necessary role in sport today and that they are effective in improving an athlete’s performance. Barriers for sports science employment were also

identified, such as a lack of opportunities, finance and a lack of practical applications and experience. Finally, in the sports team setting specifically, employers 'somewhat agreed' that sports scientists receive fair working conditions, while the practitioners 'somewhat disagreed' with this statement.

Sports scientists believed their two primary roles were to 'improve performance' and to 'plan/deliver training' while employers and coaches both described the primary roles of the sports scientist as 'supporting the coach', 'data analysis' and 'testing'. Indeed, there was much crossover between the responses of the three groups (see Figure 1), but these data suggest that sports scientists see themselves as directly impacting the athletes' performance and training. In contrast, employers and coaches see the sports scientist as supporting the coach to achieve these outcomes. There were also differences in the perceived main task of a sports scientist, however, a large number of tasks have been identified as common across the sample, highlighting the potential complexity of a sports scientist's employment and consequently, the difficulty in defining the profession (Dwyer et al., 2019). A Scope of Practice for accredited sports scientists has been published by ESSA (Exercise & Sports Science Australia, 2020), which includes statements such as 'Provision to apply knowledge to influence individual sporting needs.' Indeed, such a statement is inexplicit to allow a broad scope for the needs of different sports and innovative practice. There are five separate disciplines of sports science (see Table 3) that perform various tasks, and as such, the term 'sports scientist' actually represents a group of different sports professionals. While some sports scientists perform their role as specialists (e.g., a biomechanist hired solely for biomechanics servicing) others are required to perform a more general role including duties across multiple disciplines. Hence, the use of the umbrella term 'sports scientist' may contribute to the disparity in the understanding of the role and tasks of practitioners that have a more specific job description.

Coaches ranked sports scientists as the practitioner role with the least value to an athlete, which presents a significant issue for sports scientists in their opportunities for employment and job security. If the coach views the role of a sports scientist as less important compared to other practitioner roles, then in circumstances where the coach has influence over sports science employment, when resources are limited, their program would be less likely to employ a sports scientist. Although, the low ranking is not surprising given that coaches perceive a poor transfer of sports science knowledge to coaching practice (Martindale & Nash, 2013). Further, the regulation of the sports science industry has been enhanced only recently in response to a Senate inquiry into the practice of sports science in Australia (Greenhow, 2013), and improvements in the value and professionalism of practitioners will take some time to filter to coaches who may have had a negative experience with a sports scientist previously. Coaches have stated that sports scientists need to take a gradual and collaborative approach, and understand the language of the sport to have a greater positive influence (Dehghansai et al., 2020). It should be noted that the current study had a small coach sample, and this low ranking should be confirmed in a larger population and with interview data to explore the problem and potential solutions further. Despite this rank order, all groups in the current study agreed or strongly agreed that sports scientists have a necessary role in sport today and are effective in improving an athlete's performance. Indeed, a large amount of positive

feedback on the work of sports science practitioners was provided from all groups in the current study (see Appendix 2). The sports science discipline that is perceived by employers and coaches to be of highest priority was 'motor control and skill acquisition', which may be explained by coaches perceiving themselves to have great knowledge in this area (Fullagar et al., 2019). Such a finding suggests that education providers should have a focus on the applied practice of the motor control and skill acquisition discipline.

The key barriers noted by employers and coaches for sports science employment were 'finance', 'lack of practical applications, experience or knowledge' and 'personal/communication issues.' While finances will always be an issue in the high-performance sport setting, the other barriers may be addressed, perhaps with an increased emphasis on practical experiences and interpersonal skills within the education or accreditation pathway of practitioners. Coaches in the UK also deemed experience and practical knowledge acquired from the field to be more valuable than sports science knowledge (Martindale & Nash, 2013). Therefore, internship programs for developing sports science practitioners may be useful to assist with the development of these aspects, however, sport and exercise science graduates are known to be exploited within internships in Australia (Stevens, Lawrence, Pluss, & Nancarrow, 2018), consequently, resulting in the recent publication of the ESSA Sports Science Graduate Internship Guidelines (Exercise & Sports Science Australia, 2019). These guidelines describe how an unpaid intern should receive a 'meaningful learning experience, training or skill development' and assigning the intern with work that would usually be undertaken by an employee is considered exploitation and is against the law.

Perceptions of unsatisfactory working conditions of sports scientists in the sports team setting in the current study are consistent with data indicating they are the most unsatisfied with their jobs, likely due to high amounts of unpaid overtime potentially leading to burnout, as well as feelings of insufficient support (Dawson et al., 2013). As a result, those working at sporting clubs experience poor job longevity and are more likely to be in their position for less than five years. The current study demonstrated that employers did not recognise this issue and therefore this problem is expected to persist if action is not taken. In comparison, we found that those working at an institute or academy were somewhat satisfied with their working conditions, which explains why previous data demonstrated they are more likely to remain in their position for six years or more (Dawson et al., 2013). Employers of sports scientists in the sports team setting would likely benefit from engaging with employers in the institute/academy setting to understand how they can improve working conditions and job longevity for their staff.

It should be highlighted that this was only a preliminary study that should be used to inform future research. The current research informs further studies with the goal to establish the need to introduce title protection in line with healthcare professionals, develop resources that explicitly identify the role of a sports scientist, establish a Fair Work award for sports scientists and publish best practice position statements on sports science topics (i.e., to clarify best practice methods to complete the tasks of a sports scientist). To strengthen future studies on these themes, interview data should be included, and the limitations of the current study should also be addressed. For example, the

employers were not specifically the employers of the sports science practitioners surveyed, and hence, employers may have different roles and expectations that have been outlined clearly with their actual sports science employees. Therefore, in future studies, sports science practitioners should be recruited together with their employer and the coach that they support. Future researchers should include more participants, and better define their experience, sporting focus and the sport science discipline of these participants, and determine whether these factors contribute to variation in responses, which was not done in the current study. These considerations are needed to ensure accuracy of these results across the broad spectrum of workplaces and focus areas of sports scientists. It is likely that the roles and perceptions of sports scientists are different between individual and team sports, and even between sports within these categories.

This study identified important disparities between sports science practitioners, employers and coaches in their perceptions of sports scientists, which should be investigated further (Dehghansai et al., 2020; Waters et al., 2019). Specifically, the reasons coaches perceive sports scientists to be the practitioner role with the least value to an athlete, and secondly, reasons why sports science practitioners in the sports team setting believe they have unfair working conditions, and why employers do not recognise this. Sports science practitioners should be aware that the coach they support might perceive them to have a lower value than many other practitioners in their organisation and might find their communication styles somewhat limiting (Martindale & Nash, 2013). Sports science practitioners should demonstrate their value individually while also supporting the important work of other practitioners within their organisation. Sports science employers in the sports team setting should be aware that their sports science practitioners could perceive their working conditions to be poor (Dwyer et al., 2019). Employers should avoid poor employment practices (Wagstaff et al., 2015) and implement strategies to increase job satisfaction to prevent burnout and increase the longevity of sports science employment.

### Conflict of Interest

The authors declare no conflict of interests.

### Acknowledgment

We thank the participants for their involvement in the study.

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**Appendix 1: Questionnaire**

Q1 Are you a sports scientist, sports administrator/sports executive (who is/would be responsible for hiring a sports scientist) or a sports coach currently working in Australia?

- Yes
- No

Q2 What is your age (years)?

Q3 What is your gender?

- Male
- Female
- Other \_\_\_\_\_
- Prefer not to say

Q4 Describe your current role?

- Sports Coach
- Sports Executive/Administrator (who is/would be responsible for hiring a sports scientist)
- Sports Scientist

Q5 Describe the setting of your work (select all that apply)

- Sports team
- Sports institute or academy
- National sports organisation
- University
- Other \_\_\_\_\_

Q6 What best describes the level of the sport you're involved in?

- Professional
- National
- State
- Local

Q7 How many sports scientists are currently employed in your organisation (answer for your main organisation)?

Q8 What words first come to mind when you think of a sports scientist? (list up to 5)

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Q9 In your role or context, what is (or would be) the main role of a sports scientist?

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Q10 In your role or context, what are the main tasks of a sports scientist (select 3)?

- Training monitoring
- Athlete education
- Assessments of fitness/technique/skill/performance
- Recovery
- Goal setting
- Technique development
- Implementing interventions
- Injury prevention
- Injury rehabilitation
- Research
- Performance analysis
- Recording an athletes performance in training and competition
- Aggregating and curating records
- Designing, implementing and modifying training programs
- Other \_\_\_\_\_
- Other \_\_\_\_\_
- Other \_\_\_\_\_

Q11 In your context, rank the following sports science disciplines in order of their priority (drag and drop in to place)

- \_\_\_\_\_ Sports Biomechanics
- \_\_\_\_\_ Sports Physiology
- \_\_\_\_\_ Strength and Conditioning / Strength Science
- \_\_\_\_\_ Motor Control and Skill Acquisition
- \_\_\_\_\_ Performance Analysis
- \_\_\_\_\_ Sports Psychologist

Q12 Rank the following practitioners in order of their value to an athlete (drag and drop in to place)

- \_\_\_\_\_ Coach
- \_\_\_\_\_ Nutritionist
- \_\_\_\_\_ Physiotherapist
- \_\_\_\_\_ Sports Physician / Sports Medicine
- \_\_\_\_\_ Sports Psychologist
- \_\_\_\_\_ Sports Scientist
- \_\_\_\_\_ Strength and Conditioning Coach
- \_\_\_\_\_ High Performance Manager

Q13 Sports scientists have a necessary role in sport today

- Strongly agree
- Agree
- Somewhat agree

- Neither agree nor disagree
- Somewhat disagree
- Disagree
- Strongly disagree

Q14 In your response to the previous question 'Sports scientists have a necessary role in sport today' please explain your answer

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Q15 A sports scientist is effective in improving an athlete's performance

- Strongly agree
- Agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Disagree
- Strongly disagree

*Display This Question:*

*If Describe your current role? = Sports Coach*

*Or Describe your current role? = Sports Executive/Administrator (who is/would be responsible for hiring a sports scientist)*

Q16 I am exposed to the work of a sports scientist

- Daily
- Weekly
- Fortnightly
- Monthly
- Annually
- Never

Q17 What is the minimum qualification required to be a sports scientist?

- None
- Diploma
- Bachelor degree
- Masters degree
- PhD

Q18 What are the most important barriers preventing the employment of a sports scientist?

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Q19 In an ideal situation, with no barriers, I would employ a (or more) sports scientists to support my athlete/team?

- Strongly agree
- Agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Disagree
- Strongly disagree

Q20 Why would/wouldn't you employ a (or more) sports scientists?

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Q21 Sports scientists generally receive fair working conditions

- Strongly agree
- Agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Disagree
- Strongly disagree

*Display This Question:*

*If Describe your current role? = Sports Coach*

*Or Describe your current role? = Sports Executive/Administrator (who is/would be responsible for hiring a sports scientist)*

*Or Describe your current role? =*

Q22 Describe your level of involvement with sports science?

- Strongly involved
- Involved
- Somewhat involved
- Neither involved nor uninvolved
- Somewhat uninvolved
- Uninvolved
- Strongly uninvolved

*Display This Question:*

*If Describe your level of involvement with sports science? = Strongly involved*

*Or Describe your level of involvement with sports science? = Involved*

*Or Describe your level of involvement with sports science? = Somewhat involved*

Q23 How are you involved with sports scientists?

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**Appendix 2: Open text responses to item: ‘Please explain your answer to ‘Sports scientists have a necessary role in sport today’.**

Practitioners Sport can't move forward without research and innovation, which is what sports scientists do on a daily basis. Our role isn't fully understood by athletes and coaches, which means we tend to be underutilized; Sport Scientist's understand the body's function and movement at a deeper level. It is the role of the Sport Scientist to help advance and maintain an athlete's performance, with coaches potentially overlooking particular areas due to focusing on the skill of the sport.

Sport Scientist's play the hard-working role in the background, often providing information and guidance for the coach/athlete, which may help to enhance performance. Without sport science, advancements in athlete performances may not occur, or may occur at a slower rate.

Necessary to gain an advantage against other teams who are utilizing sport scientists for an advantage. Monitoring player load, prevent injury, designing training periodization is all the job of a sport scientist.

We are the bridge between the AT's, Strength coach and Coach in general and you have to know how to communicate also not only work but understand each position.

Performance gaps are getting smaller, and sport scientists play an important role in identifying and helping improve an athlete for those 1%ers.

Quality control on data collection is required in an elite sport so we can trust what we can collect; sports science plays a major role here.

Events are won by narrow margins, to give yourself the best chance of winning you want to ensure you are doing everything you can to succeed.

Protecting the integrity of sport through athlete management and long-term development.

Sport scientists provide a structure that allows coaches making more objective and individualized decisions. They keep track of fundamental data giving coaches a solid background helping them understand why a program/plan is successful or is not.

I believe that there is no longer an advantage in a sporting setting in having a good sport scientist, however I do believe there is a disadvantage in not having one.

Mainly a sport scientist's role is to raise more questions through answering that of the coaching staff and organization.

With many athletes, I believe that they could still achieve certain goals despite our input and help. Others seem to rely on and know how to use sports science better so work this in to their support team and use it to their advantage.

Today's coaches and athletes have access to more data and measures than ever before, but ensuring the quality of these measures and interpreting the results could mean the difference between completing the right program and completing the wrong program. Sport scientists are more important than ever because of this vast availability of products, the sellers of which are more focused on making money and reflected glory than they are on genuinely supporting elite athletic performance.

Depends on the sport and its requirements and also where the sport is at with regards to performance. Often sport scientist are not required if those people are 50% behind the game.

The sport scientist can have a crucial role if they find how to be effective in the program they work in and this will vary program to program.

To help guide the coach and athlete in terms of training loads, recovery and ergogenic aids.

We live in a high-performance environment driven by scientific and technological advancements.

Some sports could manage to perform at a very high level without a sport scientist, but in other sports (namely endurance sports), things like load management and training optimisation are critical for not tipping the athletes over breaking point. In these instances, scientists are key for providing coaches with evidence (both from the athletes they're currently working with and from the literature) to educate coaches, but ultimately it is the coach who makes the final call about what is prescribed to the athlete.

There is so much capacity for monitoring but need sport scientists to understand and apply data.

Agree. In my position it is integrated with the S&C coach which makes it more important as there is a stronger link with the team on a session to session basis.

Scientists ensure athletes get the best return for their efforts by taking a holistic approach to understanding performance and training.

Athlete wellbeing is at upmost importance to keeping athletes injury free and performing to their optimal capacities.

We have the skills to quantify the performance of individuals and teams. We equate all the information gathered from training and competition and provide this vital information to other staff and coaches. We also are the educator and motivator to the athletes. As having an individual specialise in exercise prescription benefits the athlete's development and progressions.

With technology and research constantly evolving sport science will play an important role in the translation of new research and the implementation of new technologies into sport. Sport science plays a key role in ensuring this is done safely, ethically and to high standards or accuracy.

They provide an objective, scientific foundation to training decisions and practices.

An effective coach working with any level of athlete should be able to achieve 80% of the desired adaptations and athletic developments, however an effective sport scientist can or should be able to optimise this 80% process to possibly reduce the time required and then be able to assist with achieving the remaining 20% of adaptation and development.

Ensuring evidence based practice.

As a sports scientist, I believe I have a key role in assisting an athlete to reach their potential.

Viewed as the "most educated in the room".

I think sports scientists can have an impact on sports performance as there's a lot of areas where small gains can be made, but without the help of a sports scientist a coach may not have the time, knowledge or resources to tap into these areas.

The plethora of data that is captured or able to be captured today requires the skills of a sport scientist. If you do not have someone in place covering the sports technology area in particular you will not be able to deal with all of the data that is coming in nor will you be able to utilize the latest technology that may give you information you have never had before.

With sport scientists, there would be no evidenced based practice or research based innovation in the applied sport setting.

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Employers

Depends on the practical application of knowledge as well as the way the scientist integrates into the broader team (coach, physio, S&C, athletes). How they interpret information and discuss these strategies with coaching staff/athletes.

Sports performance is an increasingly sophisticated and competitive area, and coaches cannot be fully across all aspects of their athlete's performance without a multi-disciplinary team incorporating sports scientists. They assist to manage and inform the training/adaptation and performance development process.

For performance at an elite level, athletes need a team of experts around them to keep their body in the best shape and training and competing most effectively.

In order to gain a competitive advantage.

A science-based approach is required for modern day elite level sport. Sport's scientists are the conduit to the latest research and techniques.

With the increase in technology there's a lot more to monitor, which can impact performances. The role needs to be separated from S&C coaches so each can focus on what their specific roles are.

It's crucial to maximise performance.

As Advisor to Head Coach.

Ensuring reliability and validity.

Sports Science is just one of a number of disciplines involved in HP sport.

Amateur sports lack the funding to utilise this talent and resources. Many sports are considered amateur.

In professional sport absolutely, integrity and advancement of the preparation and resilience for athletes is key.

Few sport scientists understand our sport and are not strong in applied knowledge relevant to the sport.

The role can be very different depending on the sport, the athlete mentality and their needs.

Bringing new knowledge into sport is fundamental for continued improvement.

Sports scientists have a role. However, the nature and purpose of their work needs to have an applied outcome and answer practical questions/issues faced in the applied environment.

Depends on their skill set and coach's needs.

Necessary role in providing framework for relevant data collection and translation of data to assist in improving individual and team-based training outcomes and performance.

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Coaches

If an athlete is fitter, better fuelled, recover/rehab quickly, have less injuries, improved state of mind and is confident in their support team they will perform better.

Need for sports scientists to collaborate with coaches to deliver scientific rigor to the art of coaching.

I believe that sports scientist can have a major role in the planning and monitoring of a team. I also feel at some levels they could be bought in on part time work.

How else are we going to innovate and improve our athlete's perception, decision, practice and overall performance without research and innovation?

Provide information I would not otherwise have.

Wow, how many pages do you want?? They each have unique skills and additions to each athlete. Sport is more than ever evidence based (for example selection to national team). It takes a whole team to enable an athlete to perform to the max of their ability. I'm a coach with a background in sports science so value the input of science immensely. However science does not take away from hard work and doesn't create any short cuts for the athletes, athletes don't often understand that and think because it's available they should use it. Would be better if the athletes trained their bums off first of all and use sports science services for the final few %. 95% is commitment and hard work, sports science comes into account in the last few %'s, once an athlete has a high national level or makes national teams. So as for your question below: Yes, I strongly agree to add the last final pieces towards top performance.

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They work with coaches to evaluate and design/implement training programs for athletes.

Their output needs to be relevant for now while challenging status quo - a tricky balance.

Its important the athletes have a full understanding of the importance of their bodies and how to look after them both on and off the field; They provide a necessary service that is valued if given appropriate scope of practice.

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