




# Identifying sports chiropractic global research priorities: an international Delphi study of sports chiropractors

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## ABSTRACT

**Objectives** Developing a research agenda is one method to facilitate broad research planning and prioritise research within a discipline. Despite profession-specific agendas, none have specifically addressed the research needs of the specialty of sports chiropractic. This study determined consensus on research priorities to inform a global sports chiropractic research agenda.

**Methods** A Delphi consensus methodology was used to integrate expert opinions. Clinicians, academics and leaders from the international sports chiropractic specialty were recruited using purposive sampling to participate in (1) a Delphi panel involving three voting rounds to determine consensus on research priorities and (2) a priority importance ranking of the items that reached consensus.

**Results** We identified and contacted 141 participants, with response rates for rounds 1, 2 and 3, of 44%, 31% and 34%, respectively. From the original 149 research priorities, 66 reached consensus in round 1, 63 in round 2 and 45 items in round 3. Research priorities reaching consensus were collapsed by removing redundancies, and priority ranking identified 20 research priorities, 11 related to collaboration and 6 to research themes.

**Conclusions** The top-ranked items for research priorities, research themes and collaborations included the effects of interventions on performance, recovery and return to play; clinical research in sport; and collaborations with researchers in chiropractic educational institutions, respectively.

**Implications** The prioritisation of research items can be evaluated by key stakeholders (including athletes) and implemented to develop the first international research agenda for sports chiropractic.

## INTRODUCTION

Research can advance knowledge and contribute to evidence-informed, up-to-date and safe patient care. Developing a research agenda is one method to prioritise research within a discipline. Multiple professions and organisations have developed research agendas, including emergency medical services,<sup>1</sup> nursing,<sup>2</sup> athletic therapy,<sup>3</sup> chiropractic,<sup>4,5</sup> sport psychiatry<sup>6</sup> and international sporting federations.<sup>7</sup> Over the last 5 years,

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ One method to prioritise research within a discipline is to develop a research agenda. Multiple professions and organisations have developed research agendas, including chiropractic research agendas in North America and Europe. They do not specifically address the research needs of the specialty of sports chiropractic.

## WHAT THIS STUDY ADDS

⇒ We identified a ranked list of research priorities, themes and collaborations to inform a sports chiropractic research agenda. The top ranked items in each category included the effects of interventions on performance, recovery and return to play; clinical research in sport; and collaborations with researchers in chiropractic educational institutions, respectively.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The prioritisation of research items can be evaluated by key stakeholders (including athletes), and implemented, to develop the first international research agenda for sports chiropractic.

chiropractic research agendas have been developed in North America and Europe, using Delphi methodology to achieve expert consensus on research priorities.<sup>4,5</sup> Rubinstein *et al* developed the first research agenda for the chiropractic profession in Europe,<sup>4</sup> French *et al* identified research priorities for the Canadian chiropractic profession.<sup>5</sup> While these research agendas facilitate broad research planning for the chiropractic profession, they do not specifically address the research needs of the specialty of sports chiropractic.

A recent study exploring sports-focused chiropractors' opinions on research topics suggested future research should examine the effects of sports chiropractic interventions on athletic performance, injury prevention and care of athletes.<sup>8</sup> These sports-related research interests have not been captured in



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previous Delphi studies conducted in the chiropractic profession,<sup>4,5</sup> supporting the need to develop a unique research agenda for the sports chiropractic field. Effective management and prevention of injuries in athletes must be supported by scientific evidence.<sup>9</sup> Prioritisation, coordination and implementation of a research agenda for sports chiropractors could assist in addressing the aforementioned evidence gaps. To develop a research agenda for sports chiropractors, the preliminary step is identifying research priorities. This study developed the research priorities of sports chiropractors worldwide to inform a global sports chiropractic research agenda.

## METHODS

We used Delphi methodology to determine consensus<sup>4,5</sup> and reported on our methodology using Conducting and Reporting Delphi Studies criteria.<sup>10</sup> Delphi methodology includes recruiting experts to participate in an iterative survey process that involves a systematic progression of repeated rounds of voting on a list of items and then ranking their importance. Results from each round are fed back to the experts to facilitate their subsequent voting to achieve consensus.<sup>11–13</sup> A type 4 Delphi was chosen to achieve the greatest consensus among the carefully selected experts.<sup>14</sup>

### Identification of experts

We identified participants using purposive and maximum variation sampling.<sup>15</sup> To represent the perspective of sports chiropractors worldwide, we identified experts in academic, clinical and leadership domains. We stratified potential participants by years of experience, sex, geographical region and expert domain. Inclusion criteria incorporated being a registered/licensed chiropractor or a faculty member of a chiropractic educational institution and able to complete the surveys in English. We defined three expert domains as follows:

1. Clinicians: clinician experts were defined as chiropractors with advanced certification in sports sciences. This included that they hold an International Certificate in Sports Chiropractic (ICSC) or were Internationally Certified Chiropractic Sports Practitioners (ICCSP) and are members with sports specialty designations globally. We randomly sampled members from each global region based on the percentage of the total sample after sorting by sex.
2. Academics/researchers: academic/researcher experts were defined as chiropractors or faculty members of a chiropractic educational programme who conducted sports-focused research and had at least three publications within the last 5 years. Literature searches and snowball sampling identified these participants. Snowball sampling is a method in which existing study participants aid in recruiting additional participants who may be difficult to find.<sup>15</sup> Once identified, academics/researchers were independently selected by five investigators (MB, ADL, KdL, SMP, SM) based on minimum selection criteria (including at least three

sports-focused publications in the last 5 years, considering the types and amount of publications), with final selections based on consensus among these investigators after considering overall regional distribution and sex of the potential participants.

3. Leaders: leadership experts were defined as chiropractors with an active leadership position within a sports chiropractic organisation. Participants were identified from a current list of members of the *Fédération Internationale de Chiropratique du Sport* (FICS) and individuals of the executive council, commissions, and board of directors of FICS and their member national sports chiropractic organisations. Leaders were purposively sampled based on equal representation of geographic locations and sex. Leaders holding high-ranking positions were selected first (eg, presidents, global representatives), followed by those holding lesser-ranked positions in descending order (eg, vice presidents, local representatives). If a participant was identified in more than one expert domain, the authorship team determined which group they best represented based on their available public profile.

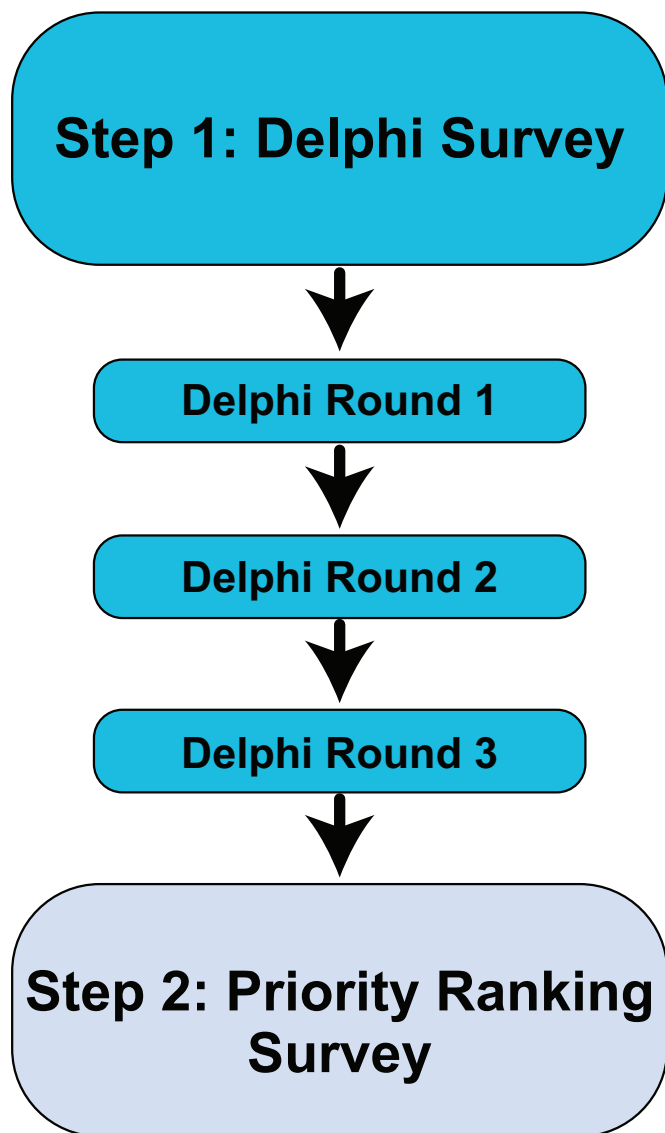
### Sampling

Sample sizes for Delphi panels range from 15 to 30 participants, with the stability of responses demonstrated with as little as 20 participants for homogeneous samples.<sup>16,17</sup> Thus, we aimed to recruit 20 experts from each of the three expert domains (clinician, academic/researcher and leadership experts) (n=60). Similar research prioritisation Delphi panels conducted for the chiropractic profession further informed our estimated sampling rate.<sup>4,5</sup> Previous Delphi studies with chiropractors reported 42% and 67% response rates for Europe and Canada, respectively.<sup>4,5</sup> To achieve 20 participants per group, we sampled 48 participants in each group, with an estimated 42% response rate.

### Data collection

We electronically distributed the survey in two steps using SurveyMonkey (Momentive, San Mateo, California, USA), which is a user-friendly platform with all required capabilities for the administration of this study internationally (see [figure 1](#)):

Step 1—Delphi survey. We reviewed 150 research priorities identified by Lee *et al*<sup>8</sup> and removed redundant or irrelevant priorities deemed irrelevant from an international scope (ie, Canadian-centric items). This resulted in 149 priorities included in Round 1. Three additional open-ended questions were included: ‘What do you think is/are the most important consensus & position statement(s) to develop?’, ‘What do you think is/are the most important guideline(s) and evidence-based care pathway(s) to develop?’ and ‘Are there other sports that sports chiropractors should research? Please specify.’. Any novel items from the latter question were reviewed by the authorship team and included as additional research directives in the subsequent Delphi round.



**Figure 1** Survey data collection steps; including three rounds of Delphi consensus surveys, and one priority importance ranking survey.

Participants were asked to rank the importance of each research priority specific to the sport chiropractic specialty. Each item was ranked on a 9-point Likert scale ranging from 1, extremely unimportant, to 9, extremely important.<sup>4</sup> Consensus on an item was considered ‘important’ (ranked from 7 to 9), of ‘uncertain importance’ (ranked from 4 to 6) or ‘unimportant’ (ranked from 1 to 3) if 70% or more of participants ranked the item accordingly.<sup>18</sup> After each round, items reaching consensus on the level of importance were included in subsequent rounds. Priorities not achieving the 70% consensus were eliminated, similar to previous Delphi

research prioritisation studies, and due to the large number of items in the survey.<sup>4,8</sup> An open text box was provided in each survey round for participants to suggest additional research priorities. We defined consensus levels a priori at 70% for Rounds 1 and 2 and 80% for Round 3.<sup>18</sup> To ensure greater unanimity and rigorously in the final list for priority ranking, the consensus level was higher for the last Delphi Round. This methodology and defining consensus levels were chosen to reduce the most important research priorities. This ensures that the final list of priority items only includes the most important to the experts.

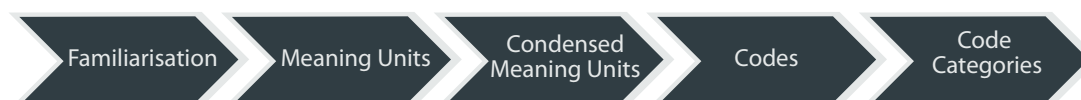
Step 2—priority importance ranking. Participants ranked the importance of each research priority that achieved consensus in Step 1. Redundancies were removed by collapsing items by consensus among research team members (MB, ADL, SMP, KdL, SM). Each item was entered in a forced ranking list from highest to least priority (‘1’ representing the highest importance ranking) in three categories: themes, priorities and collaborations. Scoring was calculated using SurveyMonkey software and verified by MB. Weights of rankings were applied in reverse, then automatically averaged to determine the top ranking (highest weighted) items. The average ranking is calculated as follows, where:  $w$ =weight of ranked position,  $x$ =response count for answer choice

$$\frac{x_1 w_1 + x_2 w_2 + x_3 w_3 \dots x_n w_n}{\text{Total response count}}$$

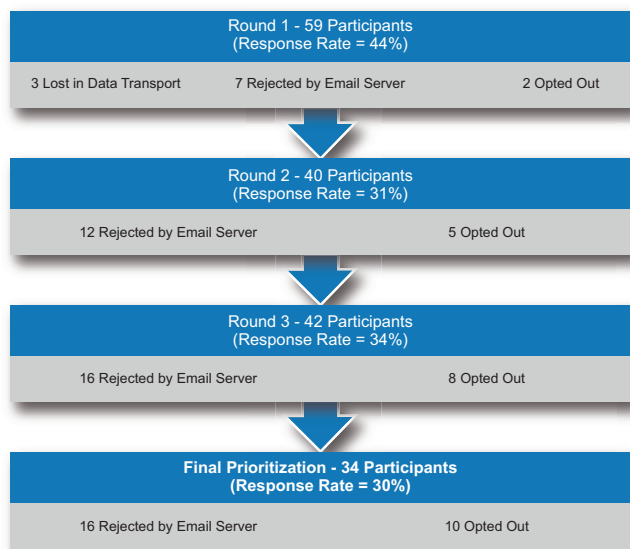
In other words, the respondent’s most preferred choice (which they rank as #1) has the largest weight, and their least preferred choice (which they rank in the last position) weighs 1. For example, if we had five items in the survey, the #1 ranked item would be assigned a weight of 5, their #2 choice a weight of 4, their #3 choice a weight of 3 and so on. All of the weighted items would be averaged across the participant responses. The final score of each survey item determines its priority, from greatest score to lowest.

### Qualitative analysis

Two open-ended questions asked the participants to share their perspectives on research priorities. We conducted a conventional content analysis (CCA), a method used to describe phenomena using information directly from study participants,<sup>19</sup> to categorise participant responses (figure 2). Coding categories were derived directly from text data following previously described steps.<sup>20</sup> Two groups of two research team members (MB & SM, CM & ADL) independently read and re-read the participant responses and created and condensed meaning units. The team members then met and formulated codes by



**Figure 2** Conventional content analysis methodology.



**Figure 3** Participant survey response rates.

consensus. A third team member acted as a code checker to maintain the core meaning of the developed codes (SM, ADL). Codes were then categorised, where possible, to create higher-level code categories.

The first round of the Delphi process was sent to participants on 24 February 2021; the second survey on 30 March 2021; the third survey on 25 April 2021 and the final prioritisation survey on 12 May 2021. Each survey was open for a total of 3 weeks. Feedback was provided to participants in subsequent survey rounds (eg, Round 1 survey data was presented in Round 2, etc). Each question's response breakdown was provided (see online supplemental file 1).

No study design violations occurred. This manuscript was prepared following the CChecklist for statistical Assessment of Medical Papers.<sup>21</sup>

### Equity, diversity and inclusion statement

The process was designed to recruit a balanced representation of participants using purposive sampling. We aimed to achieve this using ratios of sports chiropractors geographically by region, which revealed a predominance in North America. Within each geographical location, we aimed to achieve an equal gender distribution. However, recognising that the sports chiropractic profession is predominantly male and achieving equal gender representation would prove challenging despite our best efforts. Our survey included an option to self-identify gender or exclude identification of gender if that was preferred.

The diversity in the investigative team includes both male and female-identifying authors. The lead author is a junior author who identifies as a female. The co-authors have extensive research experience and a variety of perspectives from several locations globally. Our authors are located in Canada, USA, Denmark and Australia.

**Table 1** Demographic data for participants involved in the Delphi and priority importance ranking surveys

Demographic characteristics (n=69)	
Age (years) (mean, (SD))	42.7 (8.8)
Female (n (%))	21 (30)
Degree (n (%))	
Bachelor's degree	44 (63.7)
Master's degree	30 (43.5)
PhD	12 (17.4)
Chiropractic degree (eg, DC, MChiro)	52 (75)
DSc	2 (2.9)
EdD	1 (1.5)
Other	11 (15.9)
Sports specialty designations (n (%))	
International Certificate in Sports Chiropractic (ICSC)	30 (43.5)
Fellow of the Royal College of Chiropractic Sports Sciences (Canada) (FRCCSS(C))	12 (17.4)
Certified Chiropractic Sports Physician (CCSP)	15 (21.7)
Internationally Certified Chiropractic Sports Practitioner (ICCSP)	25 (36.2)
International Chiropractic Sports Science Diploma (ICSSD)	16 (23.2)
None	7 (10)
Other	13 (18.8)
Academic position at an educational institution (n (%))	
Administrative/management position at an educational institution (n (%))	9 (13)
Leadership positions in a chiropractic association(s)/organisation(s) (n (%))	44 (63.7)

### RESULTS

We invited 144 experts, 48 in each category (researchers, leaders and clinicians), of which 69 participated in this study (figure 3). Participant gender, academic degrees, residing country, sport specialty qualifications and additional positions are outlined (table 1, figure 4). The expert panel included 30% female-identified participants (n=21), with a mean age of 42.7 (SD 8.8). Educational demographic data revealed that 75% (n=52) received a chiropractic degree, 43.5% (n=30) held a Master's degree and 17.4% (n=12) held a PhD. Sports specialist designations from FICS (including CCSP, ICCSP and ICSC) were reported by 70 of the participants, meaning some participants held more than one designation. Additionally, 12 participants held the FRCCSS(C) designation, and 16 the ICSSD designation. In the leadership and academic domains, 34.8% (n=24) of participants held an academic position at an educational institution, 12% (n=9) an administrative or management role at an educational



**Figure 4** Geographic representation of study participants.

institution and 63.7% (n=44) held a leadership position at a chiropractic organisation/association.

### Round 1

Sixty-six items (44%) achieved consensus on being 'important' in Round 1. No items achieved consensus on being 'unimportant' or 'uncertain importance'. Two additional research priorities were added from participant feedback. The open text box produced 32 new items.

### Round 2

In Round 2 of the Delphi survey, 100 items were included (66 achieving consensus on being 'important' in Round 1, 2 open-text research priorities and 32 research priorities on specific sports). Of these, 63 (63%) achieved consensus on being 'important'. No items achieved consensus on being 'unimportant' or 'uncertain importance'. No new priorities were identified in open-ended responses.

### Round 3

In Round 3 of the Delphi survey, 63 items were included (from Round 2), of which 45 (71%) achieved consensus on being 'important'. No items achieved consensus on being 'unimportant' or 'uncertain importance'. No open text box was included in this round.

### Priority ranking

The list of priorities reaching consensus on being 'important' was collapsed from 45 to 37 by removing redundancies and scoring. The 37 items were divided into three research categories: 6 themes, 20 priorities and 11 collaborations. The ranking results are presented in [table 2A–C](#).

### Qualitative analysis

CCA of open-ended questions produced three main themes with 10 subheadings ([figure 5](#)). Main codes were consistent in both questions, with 'injuries and conditions', 'care/management' and 'return to play' as the major themes identified.

### DISCUSSION

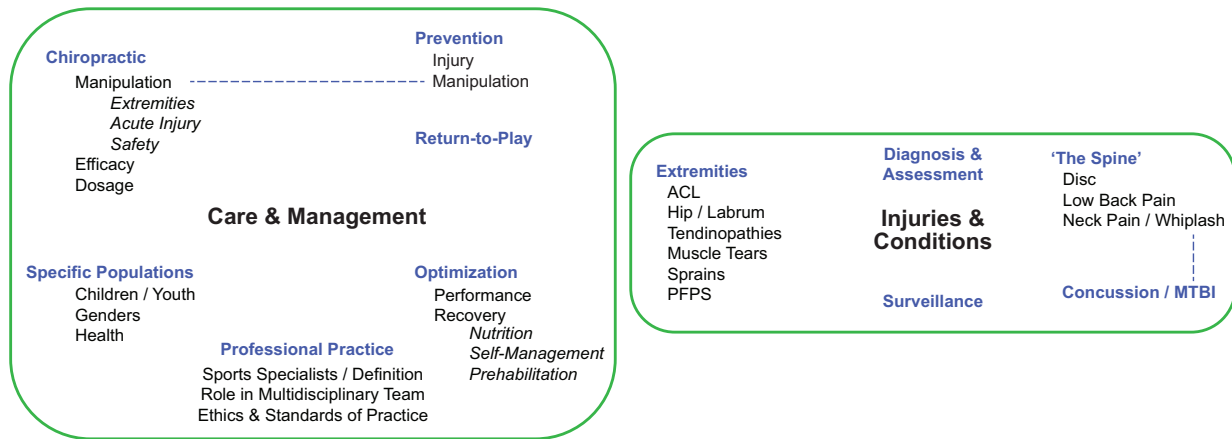
Our study provides the first step towards developing a global research agenda for the sports chiropractic specialty. Sports chiropractors globally identified and ranked research themes, priorities and collaborations. Clinical research was identified as the leading research priority, with the highest-ranked priority being the effects of interventions on performance, recovery and return to play. Of note, return to play was the most highly ranked item in the Delphi steps (receiving a vote of 100% consensus on its importance in Round 3). The qualitative analysis of the open-ended questions reflected the emphasis on these priorities, particularly the importance of return to play.

Research collaborations achieved consensus on importance and included collaborations within and outside the sports chiropractic profession. Reports suggest that international collaborative publications from sports sciences have a greater citation impact,<sup>22</sup> and although collaboration may be challenging, it is worthwhile for sports science researchers.<sup>23</sup> Moreover, results of both the Delphi methodology and the qualitative analysis identified sports chiropractors' desire to collaborate in clinical settings and research with other sports clinicians and agencies. In addition to the emphasis on research collaborations in sports chiropractors, a mixed-methods study conducted by Myburgh *et al*, 2021 of Danish chiropractors

**Table 2** (A) Final priority ranking of research themes. (B) Final priority ranking of research priorities. (C) Final priority ranking of research collaborations to pursue

(A)	
Research themes	Score*
Clinical research in sport (eg, efficacy, return to play)	5.65
Research conducted on specific sports medicine topics (eg, concussion, low back pain)	5.15
Sports chiropractic-specific research (eg, understanding sports chiropractic patients)	4.5
Research on specific sports (eg, endurance sports, athletics)	3.47
Research related to collaboration (eg, inter-professional, organisational)	3.21
Basic science research (eg, biomechanics, manipulative therapies)	3.09
Research focused on population health (eg, special athletic populations)	2.94
(B)	
Research priorities	Score*
Effects of interventions on performance, recovery and return to play (Research theme: CLINICAL RESEARCH IN SPORT)	15.21
Intervention and clinical efficacy—manipulative therapy (spinal and extremity) (Research theme: CLINICAL RESEARCH IN SPORT)	14.62
Functional assessment and treatment approaches (Research theme: CLINICAL RESEARCH IN SPORT)	13.68
Injury prevention (Research theme: CLINICAL RESEARCH IN SPORT)	13.62
Multimodal interventions (effectiveness of combining more than one intervention) (Research theme: CLINICAL RESEARCH IN SPORT)	13.29
Developing guidelines and evidence-based care pathways (Research theme: CLINICAL RESEARCH IN SPORT)	13.15
Manipulative therapy—spinal and extremity (Research theme: BASIC SCIENCE)	11.97
Comparative effectiveness studies (comparing the efficacy of one intervention against another) (Research theme: CLINICAL RESEARCH IN SPORT)	11.47
Soft tissue injuries and myofascial pain (Research theme: SPECIFIC SPORTS MEDICINE TOPICS)	11.41
Competency of sport chiropractors (Research theme: CLINICAL RESEARCH IN SPORT)	11.35
Understanding the sports chiropractic patient (Research theme: SPORTS CHIROPRACTIC RESEARCH)	10.76
Extremity research in general (Research theme: SPECIFIC SPORTS MEDICINE TOPICS)	10.29
Low back pain (Research theme: SPECIFIC SPORTS MEDICINE TOPICS)	10.29
Concussion (Research theme: SPECIFIC SPORTS MEDICINE TOPICS)	9.06
Sports biomechanics (Research theme: BASIC SCIENCE)	8.38
Special athletic populations (elite, masters, paediatric, female) (Research theme: POPULATION HEALTH)	7.85
Soccer/football (Research theme: SPECIFIC SPORTS)	6.32
Olympic sports in general (Research theme: SPECIFIC SPORTS)	6.21
Athletics/track and field (Research theme: SPECIFIC SPORTS)	5.62
Endurance sports (running, triathlon, cycling, etc) (Research theme: SPECIFIC SPORTS)	5.44
(C)	
Research collaborations to pursue	Score*
Researchers in chiropractic educational institutions/programmes	8.18
Various sports chiropractic associations/organisations	7.71
Sport and exercise medicine associations, federations and organisations	7.44
Chiropractic sports residents	6.82
Specialised sports training and development centres	6.26
Sport physicians	6.15
Multidisciplinary sports clinics in the community	5.15
Chiropractic agencies	5.12
Government agencies	4.76
Sport physiotherapy associations	4.71

\*The average ranking is calculated as follows, where: w=weight of ranked position, x=response count for answer choice.  $\frac{x_1w_1+x_2w_2+x_3w_3\dots x_nw_n}{\text{Total response count}}$   
Weights are applied in reverse. In other words, the respondent's most preferred choice (which they rank as #1) has the largest weight, and their least preferred choice (which they rank in the last position) weighs 1.



**Figure 5** Major themes identified from Q36 (‘What do you think is/are the most important consensus & position statement(s) to develop?’) and Q37 (‘What do you think is/are the most important guideline(s) and evidence-based care pathway(s) to develop?’) conventional content analysis. ACL, anterior cruciate ligament; PFPS, patellofemoral pain syndrome.

found a great emphasis on interdisciplinary management in sports settings.<sup>24</sup>

In contrast to our results, Lee *et al*<sup>25</sup> published research priorities for Canadian chiropractors working in sport. The top three research priorities identified in Canada were (1) the effects of interventions on athletic outcomes, (2) research about sports healthcare teams and (3) clinical research related to spinal manipulative and mobilisation therapy. The top three collaboration priorities ranked by Canadian chiropractors working in sport were sports physicians and universities/colleges. Interestingly, the clinical research and effectiveness of interventions on athletic outcomes (such as performance, recovery and return to play) are also reflected in the international sports chiropractic expert’s opinions. Contrary to the Canadian results, the international audience ranked collaborations with chiropractic educational institutions, chiropractic organisations and global sports organisations.

Research priorities investigated for the general chiropractic profession in Europe by Rubinstein *et al* identified 19 items that achieved consensus and were subsequently ranked according to their priority. Examples of such research agenda items included ‘cost-effectiveness/economic evaluations’, ‘identification of subgroups likely to respond to treatment’ and ‘institution and promotion of collaborative research efforts’.<sup>4</sup> Similarly, research priorities for the Canadian chiropractic profession included eight priority items, with the top-ranked priorities being ‘integration of chiropractic care into multidisciplinary settings’, ‘costs and cost-effectiveness of chiropractic care’ and ‘effect of chiropractic care on reducing medical services’.<sup>5</sup> Our study identified research priority items that were different to previous chiropractic research agendas and specific to sports chiropractors and the management of athletes.

Other professions have reported research agendas. Athletic therapists identified their research prioritisation and agenda that included: ‘healthcare competency’, ‘vitality of the profession’, ‘health professions education’,

‘healthcare economics’ and ‘health information technology’.<sup>3</sup> Their agenda reflected similarities in the priorities identified in our study, such as the effectiveness of interventions, return-to-play decisions and injury prevention. The similarities in agenda items may represent collaborative research opportunities between the two professions. Finch *et al* first identified research priority items of international sporting federations and IOC research centres.<sup>9</sup> Research centres and international sporting federations had a focus on research for injury and illness prevention in athletes. They were particularly interested in concussions, anterior cruciate ligament injuries and overuse injuries.<sup>9</sup> Similarly, injury prevention was one of the top priority items identified in our study, as well as extremity research (including anterior cruciate ligament (ACL) injuries) and concussion. Additionally, our participants identified sports and exercise medicine associations and organisations as one of the top research collaborations. These similarities in research agendas provide opportunities for collaboration and coordination of research efforts between sports chiropractors, organisations and other sports clinicians.

The research priorities we identified are a first step towards developing a global sports chiropractic research agenda. Patients and the public were not involved in this research’s design, conduct or reporting. However, the final product of a research agenda will require input from patients and other stakeholders. A research agenda for sports chiropractors is important in advancing evidence-informed care and facilitating multidisciplinary collaborative global research efforts. Coordinating global research efforts and sharing resources and knowledge is in the best interest of the athletes we serve. This collaborative research approach can provide the best care for athletes across and within sports disciplines.

### Limitations

Our sampling strategy may have missed potential participants, although we used internationally available databases and literature searches. Our response rate may

have led to response bias, although our response rate was in line with previously conducted surveys.<sup>4 5</sup> Since we used SurveyMonkey to administer the emails rather than linking to an organisational email, we may have lost participants to email server rejections (ie, undeliverable emails). The next steps in developing and implementing a research agenda will require both patients and stakeholders. Lastly, the limitations to qualitatively analysing open-ended responses include the lack of richness of the data<sup>26</sup>; however, this analysis was included in addition to our main survey data to gain additional insight into the participants' thoughts.

## CONCLUSION

The top research priorities for sports chiropractic research globally, as ranked by sports chiropractors, were clinical research in sport; the effects of interventions on performance, recovery and return to play; and research collaborations with researchers in chiropractic educational institutions. The next steps in developing and implementing a research agenda will require both patients' and stakeholders' input. Establishing a future research agenda may result in researchers interested in sports chiropractic being more efficient and productive with their efforts, which will ultimately benefit athletes through evidence-informed care.

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**Contributors** MB is the guarantor. MB, ADL and SM conceived and designed project. MB, ADL, SMP, KdL, CM and SM contributed to methodology, data collection and analysis. MB contributed to writing—original draft, with input from ADL and SM. MB, ADL, SMP, KdL, CM and SM contributed to writing—review and editing. All authors read and approved the final manuscript. Study conducted as partial fulfillment for the requirements of the Sports Sciences Residency Program: MB.

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**Competing interests** MB reports no competing interests. ADL is a member of the FICS Research Commission and chairs the Research and Education Committee of the Royal College of Chiropractic Sports Sciences (Canada). SMP reports no competing interests. KdL is a fellow and research chair of AICE Sports & Exercise group. CM reports no competing interests. SM reports no competing interests.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants and was approved by the Research Ethics Board of the Canadian Memorial Chiropractic College (REB Approval #2009X01). Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** The data that support the findings of this study are available on request from the corresponding author, MB. The data are not publicly available due to information that could compromise the privacy of research participants.

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