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Gender- and/or sex-specific considerations for sport-related injury: a concept mapping approach for the Female, woman and/or girl Athlete Injury pRevention (FAIR) consensus

Kay M Crossley ,[1,2] Melissa J Haberfield ,[1,2] Andrew G Ross ,[3] Libby J Gracias ,[1,2] Andrea M Bruder ,[1,2] Jackie L Whittaker ,[4,5] Araba Chintoh ,[6,7] Jane S Thornton ,[8,9] Margie H Davenport ,[10] Margo Mountjoy ,[11] Melanie Hayman ,[12] Brooke E Patterson ,[1,2] Cheri A Blauwet ,[13] Evert Verhagen ,[14] Carla van den Berg ,[15] Carole Akinyi Okoth ,[16,17] Caroline Bolling,[18] Dina Christina (Christa) Janse van Rensburg ,[19] Ellen Casey ,[20] Naama W Constantini,[21] Nana Akua Achiaa Adom-Aboagye ,[22] Rita Tomás,[23] Yuka Tsukahara ,[24,25] Carolyn A Emery ,[26] H Paul Dijkstra,[27,28] Alex Donaldson [29]

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For numbered affiliations see end of article.

Correspondence to
Professor Kay M Crossley; k.crossley@latrobe.edu.au

KMC and MJH are joint first authors.

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ABSTRACT

Objective This study aimed to gather and represent experts' perspectives on the gender- and/or sex-specific factors relevant to injury risk for female/woman/girl athletes.

Methods Mixed-methods concept mapping study. Sixty-six experts including cisgendered (1) athlete/coach/carers, (2) clinicians, (3) sports science/high-performance professional, (4) administrators and (5) researchers brainstormed statements to a prompt ('What gender-specific and/or sex-specific factors do you think contribute to injury risk among female, woman and girl athletes?') before thematically sorting and rating the statements/factors for importance and modifiability (5-point Likert scales).

Results Ten clusters were constructed from 101 unique statements/factors. The clusters (number of statements) include: (1) *Inequitable organisational funding and support* (n=17); (2) *Athletes' lack of, and access to, resources* (n=7); (3) *Lack of knowledge and expertise among support staff* (n=6); (4) *Lack of evidence for, and implementation of gender and sex-appropriate injury prevention* (n=20); (5) *Sex-related factors* (n=14); (6) *Gendered health* (n=8); (7) *Gendered expectations to conform to athletic ideals and norms* (n=10); (8) *Gendered harassment (interpersonal violence) and social biases* (n=9); (9) *Gendered sport environment* (7); (10) *Gendered communication* (n=3). *Lack of knowledge and expertise among support staff* was deemed the most important and modifiable cluster to address gender- and/or sex-specific factors relevant to injury prevention for female/woman/girl athletes.

Conclusion Ten gender- and/or sex-specific clusters, ranging from organisational to biological considerations and societal influences, were defined that could impact female/woman/girl athlete injury risk factors. Advancing stronger evidence for gender and sex appropriate injury prevention is urgently needed.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Female/woman/girl athletes have high and rising sport-related injury rates.

⇒ Injury prevention approaches for female/woman/girl athletes are commonly viewed through a sex-based biological lens, with the gender influences rarely considered.

WHAT THIS STUDY ADDS

⇒ This is the first study to identify considerations to reduce female/woman/girl athletes' injury risk based on the perspectives of cisgendered expert voices, including: athletes/coaches/carers, administrators, health and performance practitioners and researchers from various sport, geographical, socioeconomic and cultural backgrounds.

⇒ Concepts not typically thought to influence sport injury risk, such as the gendered sport environment, gendered health, gendered expectations, gendered harassment and social biases, unlock the potential to create innovative injury prevention solutions for female/woman/girl athletes.

INTRODUCTION

Female, woman and/or girl athletes' participation in sport is rising.[1–3] Despite the many accompanying long-term benefits, there are also high and growing injury rates.[4–7] Injury prevention efforts among female, woman and/or girl athletes are hampered by inadequate understanding of injury risk factors, exacerbated by insufficient and inaccurate reporting of gender and sex, and paucity of disaggregated data.[8 9] Across the four systematic reviews evaluating modifiable risk factors for the Female, woman, and/or girl Athlete Injury pRevention

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND OR POLICY

⇒ A critical shift in focus is needed to advance injury prevention in female/woman/girl athletes.
⇒ This study highlights the need for targeted research (beyond sex factors) on factors such as equitable access to athlete, coach and clinician education and resources, specific implementation strategies designed to address the gendered sports environment and consideration of gendered barriers to injury prevention for female/woman/girl athletes.
⇒ A novel, collaborative and multilevel approach is required to reduce female/woman/girl athlete injuries and involves the prioritisation of research, leadership and policy from sporting organisations across all levels of sport, and the establishment of equitable funding and resources to address the gender/sex specific factors that contribute to injury risk and prevention for female/woman/girl athletes.

(FAIR) consensus, less than 40% of data (range 2%–36%) were disaggregated by gender/sex.[10–12]

Within the complexity of injury risk and prevention, it is important to consider sex-related (ie, biological characteristics, such as reproductive anatomy/hormones) and gender-related (ie, socially constructed identities, roles, relations)[13] factors.[14] In this paper, we use the terms female/woman/girl, male/man/boy and gender/sex, recognising that these words are not synonymous, and can have different interpretations. When choosing these terms, we did not intend to reduce humans to their biological sex, or their gender. While different constructs, gender and sex are not distinct and often intersect and interact. For example, strength, movement control and skills, which are often considered to be sex-based injury risk factors,[15] might be influenced by socioeconomic or sociocultural contexts (including health literacy)[16 17] and gendered access to performance pathways, suitable training equipment, quality coaching, appropriate health and medical care and injury prevention programmes.[18–20] The nuances of gender/sex have not been widely evaluated in the sport injury risk context.

The socioecological model provides a useful framework to consider gender/sex-related factors across all layers of sport (figure 1). This model highlights intersections between: (1) resources, race, ethnicity, abilities and culture[20]; (2) within and across layers that influence injury risk and prevention and (3) from the individual athlete to the broader sociopolitical context.[21–23] Gender/sex considerations across the socioecological model might range from cultural considerations at the society level (eg, female, women and girls' participation in sport), organisational-level disparities in investment in resources, opportunities (eg, unequal access to high-quality professional support) and individual-level attitudes to strength training based on gendered identity (eg, femininity)[24] or beliefs about gender roles (eg, care-giving).[25 26]

Expert voices—from female/woman/girl athletes, carers (parents or guardians), coaches, administrators, health practitioners and researchers from diverse sports, geographical, socioeconomic, cultural and religious backgrounds[20 27 28]—are mostly missing from sport injury prevention research, with only ~10% of sport and exercise medicine research participants being female/woman/girl athletes. This omission perpetuates inequities through a lack of understanding of needs and context-specific interventions. It also negates evidence-informed recommendations[29 30] and gender/sex-specific considerations[14 31] and reinforces the need to listen to expert voices to uncover their perceptions of gender/sex-specific injury risk factors. This study aimed to gather and represent experts' perspectives on the gender- and/or sex-specific factors relevant to injury risk for female/woman/girl athletes.

METHODS

We employed Group Concept Mapping (GCM), a participatory, mixed-methods approach to generate, organise and conceptualise the perspectives of a diverse group of international expert participants (box 1) on the gender- and/or sex-specific factors relevant to female/woman/girl athletes' injury prevention.[32 33] GCM is an effective and efficient way to explore and develop conceptual frameworks for complex health issues.[34 35] It captures the complexity of social phenomena using robust models and analytics that yield visual representations of the strength of the relationship between ideas, involving six steps (figure 2): (1) preparation; (2) generation of statements; (3) structuring of statements; (4) representation of statements; (5) interpretation of maps and (6) development of recommendations.[34 36] GCM data collection, analysis and visualisation were conducted using the Concept Systems Groupwisdom web platform (Ithaca, New York).

Author group

A global network of early-career, mid-career and senior-career researchers from 12 countries across five continents collaborated on this study, with expertise in: (1) female/woman/girl athletes' injury prevention, implementation, female health or gender-health equity; or (2) GCM methods. They were divided into a *working group* and a *review group* (box 1). Briefly, the working group managed data collection and analysis and drafted recommendations (GCM steps 1–6; figure 2). The *review group* purposively recruited participants (mainly from personal contacts and knowledge of experts), sense-checked results, refined recommendations and reviewed manuscript drafts (GCM steps 1, 5, 6; figure 2).

Participant eligibility

Eligible participants were individuals aged ≥16 years with expertise in at least one female/woman/girl injury prevention category, defined using the 'closeness continuum'[37] box 1: (1) athlete/coach/carers, (2) clinical, (3) sports science/high-performance, (4) organisational (administration to policy) and (5) research. Our eligibility strategy aimed to ensure we collected data from participants across all levels of the socioecological model.[21]

Potential participants required computer and internet access, competency in written English (to understand GCM instructions, contribute ideas and conceptually appreciate other participants' ideas) and willingness to contribute data in GCM steps 1–3 (figure 2). No other exclusion criteria were applied. All participants consented to participate.

Concept mapping procedures

Details of the applied 6-step GCM process are provided in figure 2, including the roles/tasks of all groups at each step (ie, review group, working group, study participants). Each GCM step is described briefly below.

Step 1. Preparation

Participants were recruited between (box 1) June and August 2024 and provided demographic data through a data management platform (REDCap V.10.9.4, Vanderbilt University, USA), before being emailed a link to access the Groupwisdom

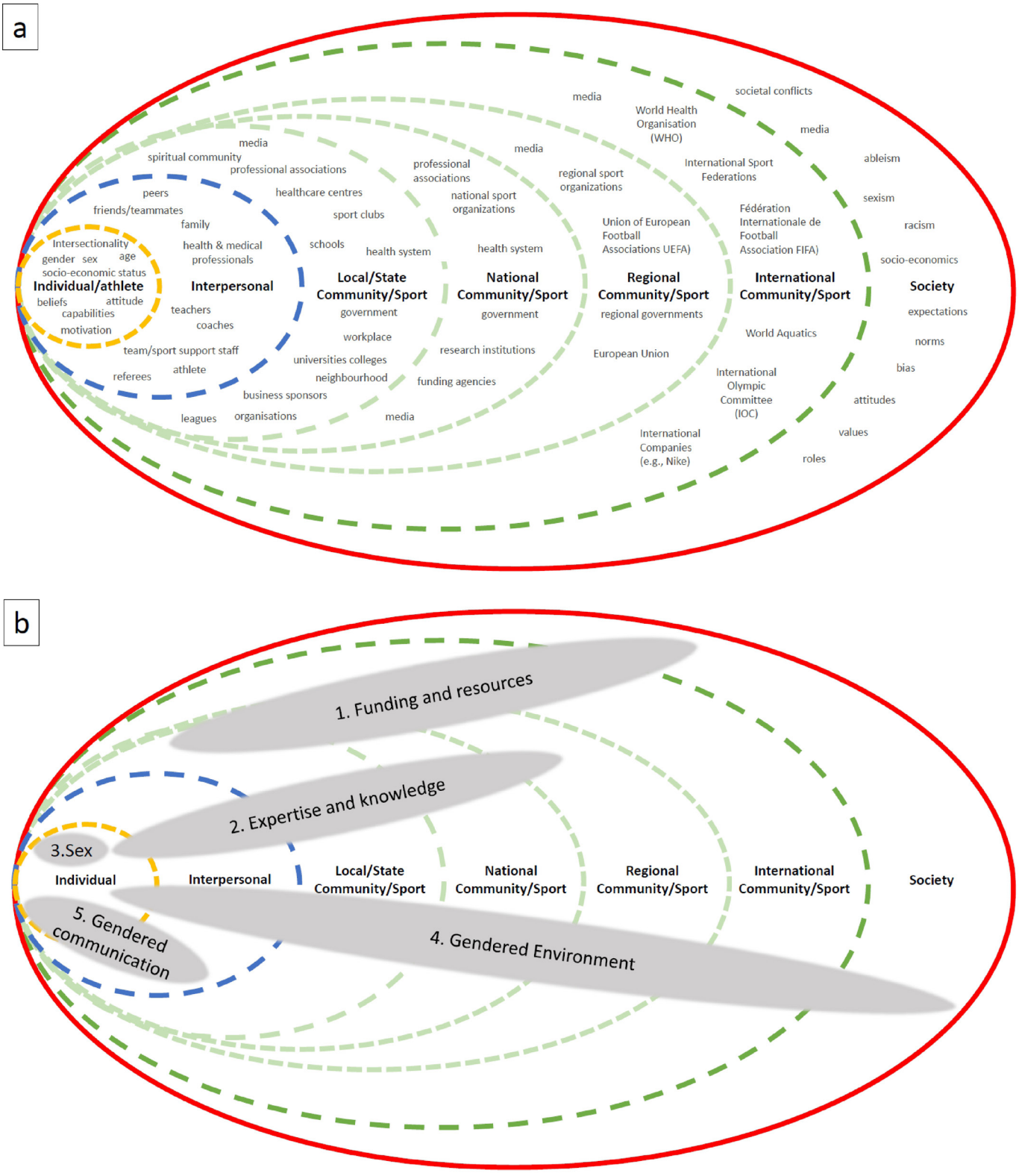


Figure 1 (a) Theoretical representation of the levels of who and what can influence gender/sex specific factors (with some examples provided in grey text) that contribute to female/women/girl athletes' injury risk and prevention. The representation is based on the socioecological model. The broken lines indicate the non-distinct nature of the levels and how influences can cross level boundaries. (b) Domains of perceived injury risk overlayed onto the levels of the adapted FAIR socioecological model that are likely to have the greatest influence. FAIR, Female, woman and/or girl Athlete Injury pRevention.

project-specific data collection web platform. Participants nominated their country of residence (later categorised as high-income or low/middle-income based on World Bank country classifications by income level for 2024–2025[24]) and primary sporting context (ie, elite (defined as national/international or professional) or community).

Box 1 Author group (working and review group) and participant definitions

Concept mapping author group (n=26).
Concept mapping working group (n=13).

Purpose: The working group led the conduct of this study including data collection, analysis and interpretation. They self-nominated from the author group and have relevant content and/or methodological expertise.

Who:KC, MJH, AR, LG, AB, AC, JW, JT, MD, MM, MH, HD, AD.

Tasks: Actively contributed to the following Group Concept Mapping (GCM) steps (details in figure 2):

⇒ Refined focus prompt and rating questions (figure 2. Step 1).
⇒ Participated in statement synthesis (figure 2. Step 2).
⇒ Followed-up with participants, checked, cleaned and approved data (figure 2. Step 3).
⇒ Analysed data including selecting appropriate cluster map, refining cluster names/boundaries (figure 2. Step 4).
⇒ Prepared and refined preliminary recommendations arising from GCM results (figure 2. Step 5).
⇒ Drafted and finalised manuscript (figure 2. Step 6).

Concept mapping review group (n=13).

Purpose: to recruit expert participants. They were allocated by the author group, had content and/or methodological expertise and were willing to recruit participants through their networks.

Who: CE, CB, BP, EV, CvdB, CB, CAO, DCJvR, EC, NC, NAAA-A, RT, YT.

Tasks: participated in the following GCM steps (figure 1):

⇒ Recruited participants (figure 2; Step 1).
⇒ Sense checked and reviewed outcomes (figure 2; Step 5).
⇒ Refined recommendations and revised manuscript (via high-level comments/feedback) (figure 2. Step 6).

Concept mapping participants (n=66)

Purpose: to gain expert perspectives on the gender and/or sex-specific factors relevant to injury prevention for female/women/girl athletes. 'Expert /expertise' was broadly defined using the 'closeness continuum' which represents an inclusive expert population with varying degrees of closeness to the topic of interest including subjective (lived-experience), mandated (professional role) and objective (academic role) closeness.[37]

Who: purposively recruited by review group to enhance diversity (gender, geography, discipline) with ~10–20 participants across each of the following categories:

1. Athlete/coach/parents/carers (eg, athletes across the lifespan, all abilities, all levels).
2. Clinicians (eg, physiotherapists, doctors, dietician, psychologists, podiatrist, orthotist).
3. Sports science (eg, exercise scientists/physiologists, high/performance coaches/staff, biomechanist).
4. Organisational from administration through to policy (eg, team managers, chair/board members).
5. Researcher with no clinical/athlete-facing role (eg, methodologist, sport scientist, exercise physiologists, neurophysiologists, biomechanist, sociologist).

Tasks: participated in the following GCM steps (figure 2):

⇒ Provided demographic data (figure 2. Step 1).
⇒ Brainstormed statements in response to the GCM prompt (figure 2. Step 2).
⇒ Thematically sorted statements into piles, rated statements for importance and modifiability (figure 2. Step 3).

Step 2. Statement generation

Participants had unlimited access to the study platform to brainstorm as many ideas as they wanted in response to a focus prompt (and explanation): *What gender- and/or sex-specific factors do you think contribute to injury risk among female, woman and girl athletes?* To encourage participants to apply a socioecological lens to their thinking and responses, we asked them to *consider:*

- *All sports and all levels of sport*
- *Factors that contribute to higher injury risk among woman and girl athletes when compared to men and boy athletes*
- *All types of injuries and injury outcomes*
- *Factors that contribute before, during and after an injury*
- *Factors related to the athlete, the people around them, the sports system and broader society*
- *Your experiences, the experiences of people you know and any evidence that you are aware of.*

Following brainstorming, the working group developed a final list of unique, single-item statements (retaining original wording where possible).[36]

Step 3. Structuring of statements

All participants, irrespective of step 2 contributions, were invited to thematically sort statements into piles and name the piles they created. After sorting, participants rated each statement for both *relative importance*, and *relative modifiability*, respectively*: Using a scale of 1 (least) to 5 (most), please rate the relative importance/modifiability of each of these factors as a contributor to injury risk among female, woman and girl athletes.*

Step 4. Representation of ideas

A two-dimensional *point map* (online supplemental file 2) and series of *cluster maps* (15 to 5 cluster solutions) were produced using multidimensional scaling and hierarchical cluster analysis,[34 36] respectively. The working group selected the most appropriate cluster map to represent the participants' sorting data and adjusted cluster boundaries to ensure the best conceptual fit for each statement. For boundaries to be redrawn so that a statement was included in a neighbouring cluster, the statement needed to be (1) on the edge of its current cluster, (2) supported by strong quantitative spanning data[34 36] and (3) supported by the working group. The working group then named each cluster based on the statements within the cluster and the names used by participants during sorting.

Mean importance and modifiability ratings were calculated for each statement and used to generate a '*Go-Zone*' Graph and three *pattern match graphs*.[34 36] *Pattern match graphs* were used to visually represent and compare: (1) mean importance and modifiability scores for each cluster, and (2) mean importance scores for each cluster between groups of interest (ie, participants from elite vs community sporting contexts (online supplemental figure 3)), and participants residing in high-income vs low/middle-income countries (online supplemental figure 4).

Steps 5 and 6. Interpretation of maps and development of recommendations

The working group reviewed the final cluster map to see if a higher level domain organisation of clusters was justified.[38] Through qualitative synthesis and working group consensus, the higher level domains were constructed by grouping thematically related clusters to acknowledge the complex interaction between clusters and enhance conceptual clarity and applicability. This facilitates broader interpretation of the concept map to assist with translation of findings into actions targeted at specific dimensions of the sports

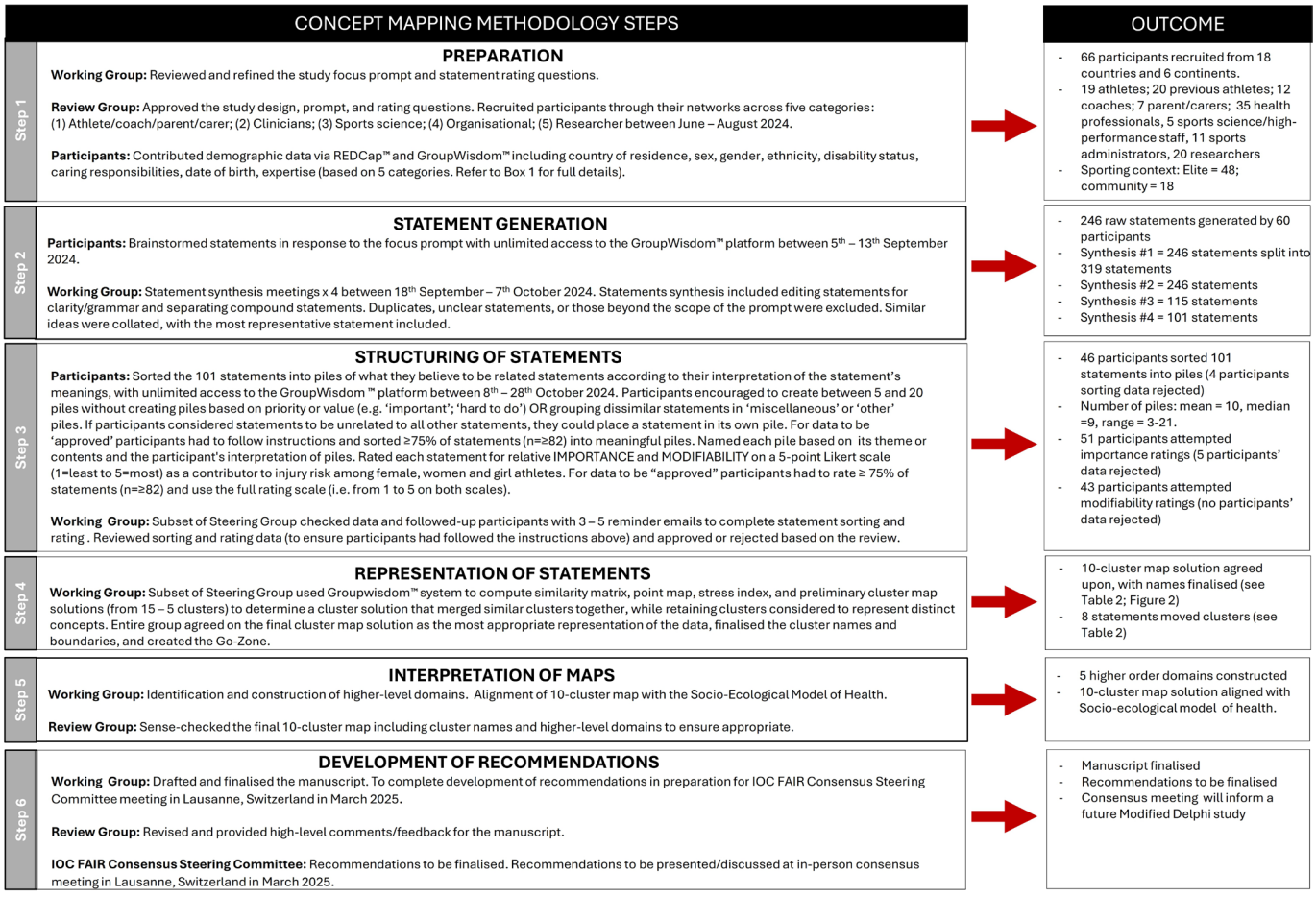


Figure 2 Six steps of Group Concept Mapping (GCM) methodology and outcomes. GroupWisdom = Concept Systems GroupWisdom is the web platform used to employ GCM, a participatory, mixed-methods approach to generate, organise and conceptualise the perspectives of the participants in response to the prompt. Socioecological model of health=is a theoretical framework used in behavioural science and public health used to gain understanding on the complex interplay of individual, interpersonal, organisational, community and societal factors that influence health. FAIR, Female, woman, and/or girl Athlete Injury pRevention; IOC, International Olympic Committee.

system. The working group then prepared a list of recommendations arising from the final cluster map that aligned with the socio-ecological model.[21]

RESULTS

Figure 2 summarises the GCM outcomes from steps 1–6. Table 1 summarises the characteristics of the 66 participants who contributed data (steps 1–3; figure 2). Participants mostly self-identified as female/woman/girl (56, 85%) and white (49, 74%). They were from six continents (23% from low-income or middle-income countries) and five (8%) identified as living with a disability. Participants reported having current or prior experience and/or expertise as an athlete (66%), and/or current roles within sport as a: coach (18%), health, medical or exercise practitioner (61%), administrator (17%) and researcher (30%).

Sixty-one participants brainstormed 246 statements (figure 2, step 2). After statement synthesis (figure 2, step 2), 51 participants sorted and rated (figure 2, step 3) 101 statements (table 2). A 10-cluster map, grouped into five higher level domains (figure 2, step 4–5, table 2), was identified as the best representation of the participants' sorting data.

The 5 domains and 10 clusters (including number of statements, mean importance (1 least; 5 most)), and mean modifiability (1 least; 5 most) (figure 3) were:

Domain 1: Funding and resources

1. Inequitable organisational funding and support (17 statements; 3.42; 3.48).
2. Athletes' lack of, and access to, resources (7 statements; 3.70; 3.98).

Domain 2: expertise and knowledge

3. Lack of knowledge and expertise among support staff (6 statements; 3.77; 4.06).
4. Lack of evidence for, and implementation of gender and sex-appropriate injury prevention (20 statements; 3.61; 4.11).

Domain 3: sex

5. Sex-related factors (14 statements; 3.15; 2.29).

Domain 4: gendered environment

6. Gendered health (8 statements; 3.07; 3.19).
7. Gendered expectations to conform to athletic ideals and norms (10 statements; 3.06; 3.15).
8. Gendered harassment (interpersonal violence) and social biases (9 statements; 3.07; 3.09).
9. Gendered sport environment (7 statements; 3.10; 3.44).

Domain 5: Gendered communication

10. Gendered communication (3 statements; 2.86; 3.81).

The Go-Zone graph (figure 4) included 37 statements rated above the grand mean for both importance and modifiability (Q1). The importance versus modifiability pattern match graph (online supplemental file 1) highlighted similarities in the order

Box 2 Equity, diversity and inclusion and patient and public involvement details

Equity, diversity and inclusion

Review planning and design: the Female, woman, and/or girl Athlete Injury pRevention (FAIR) Consensus Steering Committee planned and designed this project. This group (n=24, 80% women; n=17, 71% affiliated with International Olympic Committee (IOC) Research Centres for prevention of injury and protection of athlete health) includes academics and sports medicine/health professionals (n=19; 79%) with broad expertise ranging from epidemiology (n=18; 75%), injury prevention (n=21; 88%), sport sciences (n=4; 17%), health promotion (n=2; 8%) and career stage (n=7 late-career, n=9 mid-career, n=8 early career) from four continents, who are mostly white, and from well-resourced countries.

Authors: authors were chosen by the FAIR Consensus Steering Committee based on relevant and diverse expertise. Thirteen members (50%) have experiences and/or expertise as athletes; 9 (35%) as coaches and 22 (85%) as health, medical or exercise practitioners. Members serve on committees related to sporting organisations (15, 54%); government (n=5, 19%), industry (n=3, 12%) and healthcare (n=11, 42%). All gender identities, sexes and abilities were welcomed. Authors self-identified as mostly female (22, 85%) and reported their ethnicity as white 21 (80%), 2 (8%) Asian, 3 (12%) black (African)/African American and 1 (4%) Hispanic/Latino. Of the 26 authors, 13 (50%) had para-sport experience, and 26 (100%) and 24 (92%) had female/woman/girl youth and senior athlete experience, respectively. Authors had broad representation across research career stages: 19% senior, 31% mid-career; 27% early-career and 11% PhD/Masters students. Countries of birth and residence were classified as a high-income or a low-income or middle-income country based on the World Bank country classifications by income level for 2024–2025. 39. 80% of authors were born (with lived experiences) in high-income countries across six continents (20% from low-income or middle-income countries) and 88% were residing in high-income countries (five continents). Author data were collected electronically in English to facilitate access, which required computer and internet access.

Patient and public involvement

FAIR Consensus External Advisory Committee (EAC): The FAIR EAC consists of eight women with lived experiences as elite (n=1 Olympian, n=1 Paralympian) and youth (n=1) athletes, team physicians/physiotherapists (n=3), coaches (n=2), sport scientists (n=1) and leadership roles in sport (n=5), government (n=2), industry (n=1) and healthcare (n=5) organisations spanning multiple ethnicities (62.5% white), birth countries (50% from low to middle-income) and abilities (n=4 Para sport). The EAC level of engagement is consistent with the International Association for Public Participation 'consult' or 'involve' level with tasks including reviewing and providing feedback on recommendations. The EAC will also participate in future knowledge translation activities.

Table 1 Group Concept Mapping participant demographics

	Included participants
Variable	n=66 (100%)
Gender	
Woman	56 (85%)
Man	10 (15%)
Gender diverse	0 (0%)
Gender not specified	0 (0%)
I prefer not to answer	0 (0%)
Sex	
Female	56 (85%)
Male	10 (15%)
Intersex	0 (0%)
Sex not specified	0 (0%)
I prefer not to answer	0 (0%)
Age (median; IQR; range)	41 (33, 48); 17–64
Continent	
Asia	5 (8%)
Africa	9 (14%)
Australia/Oceania	10 (15%)
Europe	13 (20%)
North America	25 (38%)
South America	4 (6%)
Classification of income level of country of residence*	
High	51 (77%)
Middle or low	15 (23%)
Ethnicity (select all that apply)†	
Asian	7 (11%)
Black (African)/African American	6 (9%)
First Nations	0 (0%)
Hispanic/Latino	3 (5%)
Middle Eastern/North African	1 (2%)
Native Hawaiian/Pacific Islander	0 (0%)
White	49 (74%)
Not listed	2 (3%)
I prefer not to answer	1 (2%)
Do you identify as a person with a disability?	
No	60 (90%)
Yes	5 (8%)
Prefer not to answer	1 (2%)
Primary sport setting	
Elite	48 (73%)
Community	18 (27%)
Role within sport (select all that apply)†	
Current athlete	19 (29%)
Previous athlete	20 (30%)
Coach	12 (18%)
Carers	7 (11%)
Health professional	35 (53%)
Sport science/high-performance staff	5 (8%)
Organisation/sports admin	11 (17%)
Researcher	20 (30%)
Group Concept Mapping data contribution	
Brainstorming	61 (92%)
Sorting	47 (71%)
Importance rating	51 (78%)
Modifiability rating	43 (66%)

*Indicates participants were classified as residing in either a high-income country or a low or middle-income country based on the World Bank country classifications by income level for 2024–2025.[69]
†Indicates participants could nominate more than one category.

Table 2 Synthesised statements grouped by cluster including bridging value, mean importance and modifiability ratings (SD) and Go-Zone quadrant

Number	Statements	Bridging value*	Importance mean †	Modifiability mean †	Go-Zone‡
DOMAIN 1: FUNDING AND RESOURCES					
1. Inequitable organisational funding and support (SD)§		**0.30**	**3.42 (0.41)§**	**3.48 (0.32)§**	
74	Financial barriers for women's teams compared with the men's teams (eg, less resources, fewer and less experienced staff)	0.14	4.04	3.63	Q1
29	Inequal access to facilities and competition for female/women/girl athletes	0.15	3.89	3.79	Q1
67	Women's sports eco-system unable to adequately remunerate experienced staff	0.29	3.78	3.55	Q1
32	Lower investment in infrastructure when compared with men sports at all levels	0.11	3.78	3.53	Q1
81	Fewer financially sustainable professional opportunities for female athletes so they are less likely to treat their athletic careers as seriously as men	0.30	3.65	3.40	Q2
21	Lack of access to high-quality training spaces (playing surfaces and conditions) when compared with boys/men for the same sport and competition level	0.20	3.61	3.74	Q1
88	Expecting women to perform at the same level with less resources as men	0.33	3.59	3.42	Q2
72	Dual career part-time athletes including those who work multiple jobs outside of their professional sporting career—leaving less time for recovery	0.48	3.59	3.05	Q2
1	High performance sport opportunities more available for males from an earlier age	0.37	3.54	3.40	Q2
63	Inadequate social support systems (eg, public childcare, healthcare access, insurance, housing) tailored to female athletes	0.38	3.46	3.23	Q2
93	Financial constraints when injured and cannot afford expertise for treatment	0.17	3.42	3.05	Q2
39¶	A lack of policy to support travel with young families which impacts ability to train, sleep and recover from training load	0.38	3.37	3.53	Q1
23	Where male and female athletes compete on the same courses, these are often designed with male athletes in mind	0.47	3.37	3.49	Q1
51	Lack of gender-specific equipment (eg, due to cost)	0.17	3.09	3.51	Q3
73	Sub-par travel and accommodation for female athletes compared with men	0.11	2.80	3.76	Q3
69	Cost of equipment replacement and maintenance for individual athletes	0.17	2.65	2.86	Q4
59¶	Lack of access to period care and sanitary products	0.81	2.54	4.30	Q3
2. Athletes' lack of, and access to, resources (SD)§		**0.58**	**3.70 (0.33)§**	**3.98 (0.16)§**	
9	Inequity (including unequal/lack of access) of strength and conditioning training compared with boys/men's programmes, starting through adolescence	0.59	4.28	4.31	Q1
90	Lack of funded screening/management for issues that affect performance in women (eg, pelvic health, endometriosis, pelvic pain, breast pain)	0.77	3.93	3.98	Q1
18	No access to appropriate professional supports (nutritionists, physiotherapists) for female, women and girl athletes	0.39	3.74	3.98	Q1
5	Fewer post-competition and post-practice recovery resources for female, women and girl athletes (eg, food, trainers, pro-active physiotherapist)	0.38	3.73	4.05	Q1
64	Resources designed for males are used for female (eg, training programmes, recovery)	0.62	3.63	3.84	Q1
35	Uniform and footwear requirements designed for male body shapes do not allow for women's specific differences	0.58	3.39	3.95	Q1
70	No access to pelvic floor physical therapy/physiotherapy (particularly regarding return to sport after childbirth)	0.75	3.20	3.77	Q3
DOMAIN 2: EXPERTISE AND KNOWLEDGE					
3. Lack of knowledge and expertise among support staff (SD)§		**0.57**	**3.77 (0.19)§**	**4.06 (0.29)§**	
3	Limited medical staff knowledge in women's sports (eg, less experienced/educated)	0.52	4.09	4.26	Q1
85	Lack of research/education for female-specific training, coaching, development	0.67	3.91	4.28	Q1
11	Lack of coach expertise in teaching techniques to women	0.53	3.78	4.05	Q1
28	A lack of skill acquisition focus from coaches, especially in developmental phase	0.63	3.74	4.35	Q1
22	Coaches who have come from male sport to female sport expecting it to be the same from a training and loading perspective	0.49	3.57	3.51	Q1
30	Lack of female coaches who understand female athletes	0.56	3.54	3.91	Q1
4. Lack of evidence for, and implementation of gender and sex-appropriate injury prevention (SD)§		**0.63**	**3.61 (0.38)§**	**4.11 (0.29)§**	
34	Poor knowledge/level of education on the female body among coaches, fitness coaches, strength trainers and medical staff	0.65	4.11	4.30	Q1
75¶	Most research is based on men and boys; nothing available for community level	0.64	4.11	4.12	Q1
95	Lack of emphasis on building strength at younger sporting ages (eg, puberty)	0.58	4.09	4.26	Q1
62	A lack of focus on building and maintaining strength/muscle in female sports	0.67	4.04	4.33	Q1
100	Not enough emphasis on working on proper training techniques (eg, neuromuscular recruitment) at younger sporting ages	0.55	3.98	4.47	Q1
96	Lack of understanding/implementation of exercise-based injury prevention	0.50	3.98	4.31	Q1
101	Lack of knowledge on issues impacting injuries specific to women (eg, pelvic/breast)	0.69	3.80	4.21	Q1
56	Training/recovery programmes may not account for specific needs of female athletes	0.54	3.78	4.31	Q1
24	Low prioritisation of proven methods to avoid injury from coaches/training staff in women's sport	0.51	3.73	4.21	Q1
53	Lack of research/knowledge (eg, coaches, support staff, athletes) on menstrual cycle/hormonal contraception and the impact on health/performance	0.72	3.67	4.19	Q1
45	Lack of neuromuscular warm-up routines used prior to practices and games	0.60	3.63	4.51	Q1
78	Insufficient knowledge on sport/training during pregnancy and returning in the post-natal period	0.72	3.63	4.05	Q1
77¶	Research/dissemination on women's sport/injury risk is not conducted by women	0.65	3.42	3.84	Q1
68	Misinformation on what healthy nutrition is for female athletes	0.73	3.37	4.26	Q1
50	The sports system may not always accommodate or educate athletes and coaches about training programmes and the menstrual cycle	0.63	3.38	4.02	Q1
92	Coach/fitness coach perceptions of fitness (strength, power, etc.) requirements of females is lower than for males	0.57	3.35	4.00	Q1
65	Inappropriate weight management by coaches.	0.59	3.22	3.88	Q3
66	Training considerations around the phases of the menstrual cycle	0.76	3.07	3.60	Q3

Continued

Table 2 Continued

Number	Statements	Bridging value*	Importance mean †	Modifiability mean †	Go-Zone‡
97	Low sports technical ability of female, women and girl athletes (eg, tackling)	0.64	3.00	4.07	Q3
98¶	Lower training age of female athletes compared with their male counterparts	0.65	2.85	3.26	Q4
DOMAIN 3: SEX					
5. Sex-related factors (SD)§		**0.21**	**3.15 (0.37)§**	**2.29 (0.71)§**	
47	Higher incidence (than male athletes) of REDs (relative energy deficiency in sport) undiagnosed at clinical levels, leading to increased fatigue	0.44	3.84	3.28	Q2
76	Physical changes during pregnancy and postpartum, interruptions in training	0.22	3.64	2.12	Q2
58	Differences in neuromuscular control (eg, balance, landing, running mechanics) among female/women/girl athletes compared with male/men/boy athletes	0.63	3.57	3.53	Q1
7	Female-specific puberty-related changes	0.17	3.50	2.00	Q2
43	Reproductive hormone differences and the impact of menstrual and lifespan hormonal changes on injury risk	0.34	3.22	2.28	Q4
61	Hormonal fluctuations during the menstrual cycle may increase risk of injury	0.23	3.20	2.07	Q4
52	Female athletes are more prone to iron deficiency than males due to menstrual blood loss and increased iron needs	0.21	3.13	2.95	Q4
17	Body composition differences in female/women/girl and male/men/boy athletes	0.05	3.11	1.95	Q4
38	Differences in joint laxity in female athletes compared with male athletes	0.02	3.09	1.70	Q4
12	Breast mass, poor sports bra support, breast injuries (eg, contact trauma to breast)	0.59	2.96	3.47	Q3
4	Females generally have a wider pelvis and a larger Q angle (angle between the quadriceps line and the patella line) compared with men	0.00	2.84	1.35	Q4
2	Females have more knee valgus	0.01	2.76	1.58	Q4
19	Lower bone density in female athletes	0.03	2.71	2.26	Q4
27	Differences in tibial slope in female athletes compared with male athletes	0.01	2.52	1.47	Q4
DOMAIN 4: GENDERED ENVIRONMENT					
6. Gendered health (SD)§		**0.89**	**3.07 (0.46)§**	**3.19 (0.34)§**	
87	Pregnancy/postpartum psycho-social changes (eg, sleep, breast feeding, social support)	1.00	3.67	2.93	Q2
71	The prevalence of disordered eating among female, women and girl athletes	0.98	3.57	3.02	Q2
55	Perceptions of female athletes regarding the influence of menstrual cycle phase and hormonal contraceptive use on injury risk	0.76	3.30	3.67	Q3
25	The stigma related to talking about the menstrual cycle is common in sports	0.96	3.18	3.74	Q3
79	Women appear to rate concussion baseline symptoms differently to men, which potentially influences post-injury ratings as well	0.97	2.98	2.77	Q4
83	How fear of re-injury is perceived and managed	0.85	2.93	3.37	Q4
94	Sleep quality factors related to gender (eg, mental health/hormones)	0.65	2.85	2.91	Q4
13	Attention deficit hyperactivity disorder is overlooked/underdiagnosed in female athletes	0.92	2.09	3.12	Q4
7. Gendered expectations to conform to athletic ideals and norms (SD)§		**0.64**	**3.06 (0.23)§**	**3.15 (0.11)§**	
26	Female athletes feeling like they need to meet societal ideals of what their bodies should look like so they resort to unhealthy behaviours to achieve those standards, which can lead to adverse outcomes	0.69	3.42	3.19	Q2
15	Fat stigma and body shaming	0.88	3.36	3.33	Q2
82	Psycho-social factors/pressure/expectations to perform and challenge yourself	0.52	3.30	3.00	Q4
80	Psychologically, females are tough. Many would go through pain thinking it is something that is either part of elite training or the sport itself. This may lead to chronic injuries, untreated injuries or underestimated/undiagnosed injuries	0.71	3.15	3.21	Q4
8	Female, women and girl athletes feeling overlooked so pushing harder	0.53	3.04	3.07	Q4
44	Women will tend to push through and not tell anyone about an injury. They may want to not risk looking emotional or weak if feeling a pain somewhere	0.51	2.96	3.23	Q4
14	Females trying to hide symptoms to be treated fairly	0.63	2.91	3.02	Q4
16	Embracing masculine norms of not wanting to be weak, ask for help, or rest	0.62	2.87	3.16	Q4
86	Girls often lack confidence in their abilities and may hesitate to try new things	0.56	2.77	3.26	Q4
48	Trying to fit into sport by being hyper-masculine (eg, aggressive, risk-taking) can increase injury risk	0.77	2.76	3.02	Q4
8. Gendered harassment (interpersonal violence) and social biases (SD)§		**0.84**	**3.07 (0.38)§**	**3.09 (0.45)§**	
6	Gendered expectations to be the caregiver at home, taking time away from physical preparation and increasing fatigue and stress	0.80	3.49	2.81	Q2
10¶	Stigma/negative perceptions around strength training and key dynamic lifts (eg, squat, lunge, deadlift)	0.91	3.46	3.93	Q1
31	Within sporting teams, the external factors of work/family commitments vary so much and load in training/sessions is kept the same	0.86	3.31	3.00	Q4
99	Gendered physical harassment	0.90	3.26	3.49	Q3
89	Constantly navigating sexist behaviour for example, dismissive remarks/biased treatment	0.82	3.15	3.19	Q4
42¶	Gendered play when young, before sport starts, can set up girls/women to move in a way that may predispose them to injury once they start sport	0.82	3.13	3.14	Q4
54	Gendered parenting and how parents change the way they interact with their children based on the child's gender	0.75	2.96	2.91	Q4
40	Female athletes are often socialised to prioritise (team) harmony and cooperation over individual success	0.74	2.69	3.12	Q4
33	Wearing a hijab might cause heatstroke or can limit range of motion	0.96	2.22	2.19	Q4
9. Gendered sport environment (SD)§		**0.71**	**3.10 (0.12)§**	**3.44 (0.46)§**	
36	Less depth of play and competition, therefore talented female athletes move quickly through the ranks, sometimes before they are physiologically ready	0.63	3.28	3.12	Q4
49¶	Increased games/fixture congestion in a calendar year (compared with previous years)	0.66	3.20	3.42	Q4
91	Assumed less competitive and more social nature of women's sport, leading to inadequate preparation/warm up, recovery, etc	0.71	3.17	3.88	Q3
41	Game intensity has increased significantly compared with previous years.	0.79	3.15	2.49	Q4
46	Gendered workout/gym spaces where men dominate and intimidate prevent girls/women from going in there in the first place	0.76	3.04	3.86	Q3

Continued

Table 2 Continued

Number	Statements	Bridging value*	Importance mean †	Modifiability mean †	Go-Zone‡
84	Less willingness for people to help female athletes return to sport (eg, more acceptance of dropping out)	0.68	2.96	3.77	Q3
57	Lack of female role models to emulate	0.74	2.91	3.51	Q3
DOMAIN 5: COMMUNICATION					
10. Gendered communication (SD)§		**0.77**	**2.86 (0.28)§**	**3.81 (0.25)§**	
60	Different communication approaches may be needed (compared with males) when discussing injury risk	0.86	3.07	4.16	Q3
20	Coaches more inclined to dismiss symptoms that could lead to an injury for females	0.80	3.04	3.63	Q3
37	Officials (eg, umpires/referees) have no comprehension of how to interact with different genders based on their needs	0.64	2.47	3.65	Q3
All statements		–	**3.33****	**3.42****	

*Values range between 0.00 and 1.00. **Individual statement:** values close to 0 identify anchoring statements that are likely to represent the core concept of the cluster and be closely related to other statements in a cluster; values close to 1 identify bridging statements that are connected to statements in other clusters or areas on the map. **Cluster values** close to 0 indicate a conceptually tight grouping of statements within the cluster; values close to 1 indicate a group of more loosely connected statements within the cluster.
†1=least; 5=most.
‡Go-Zone quadrants: *Q1,* statements rated above the grand mean (ie, the mean for all statements) for importance and modifiability; *Q2,* statements rated above the grand mean for importance and below the grand mean for modifiability; *Q3,* statements rated below the grand mean for importance and above grand mean for modifiability; *Q4,* statements rated below the grand mean for importance and modifiability.
§SD for cluster mean rating values.
¶Statement reassigned from adjacent cluster when the cluster boundaries were redrawn (n=8).
**Grand mean for all statements.

of clusters across both scales, with two exceptions: *Gendered communication* was rated the least important, but fourth most modifiable, while *Sex-related factors* were rated fifth most important but least modifiable. The elite versus community pattern match graph (online supplemental file 3) showed similar order of importance ratings between groups, except for *gendered expectations to conform to athletic ideals and norms* (rated ninth most important by elite sport participants and fourth most

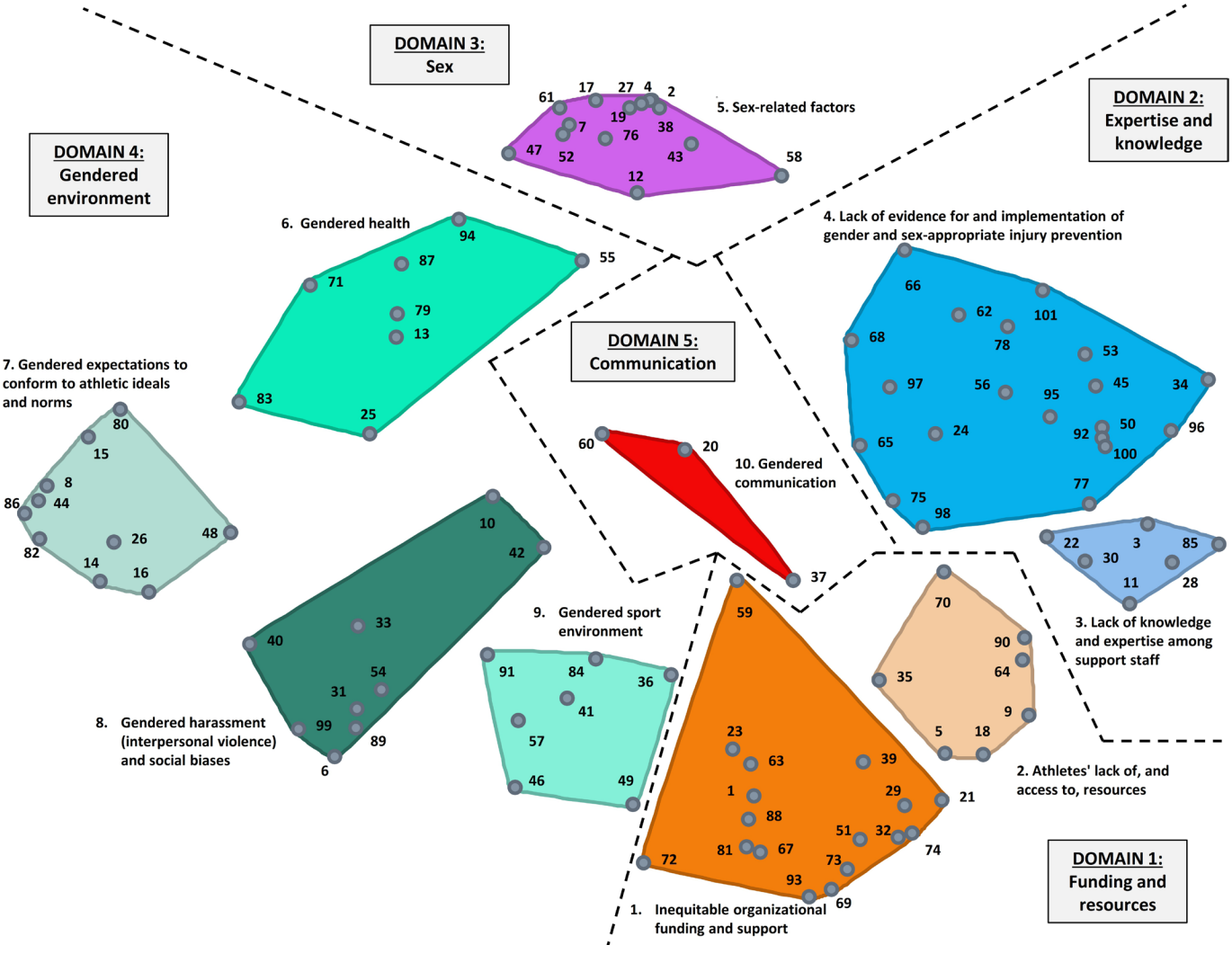
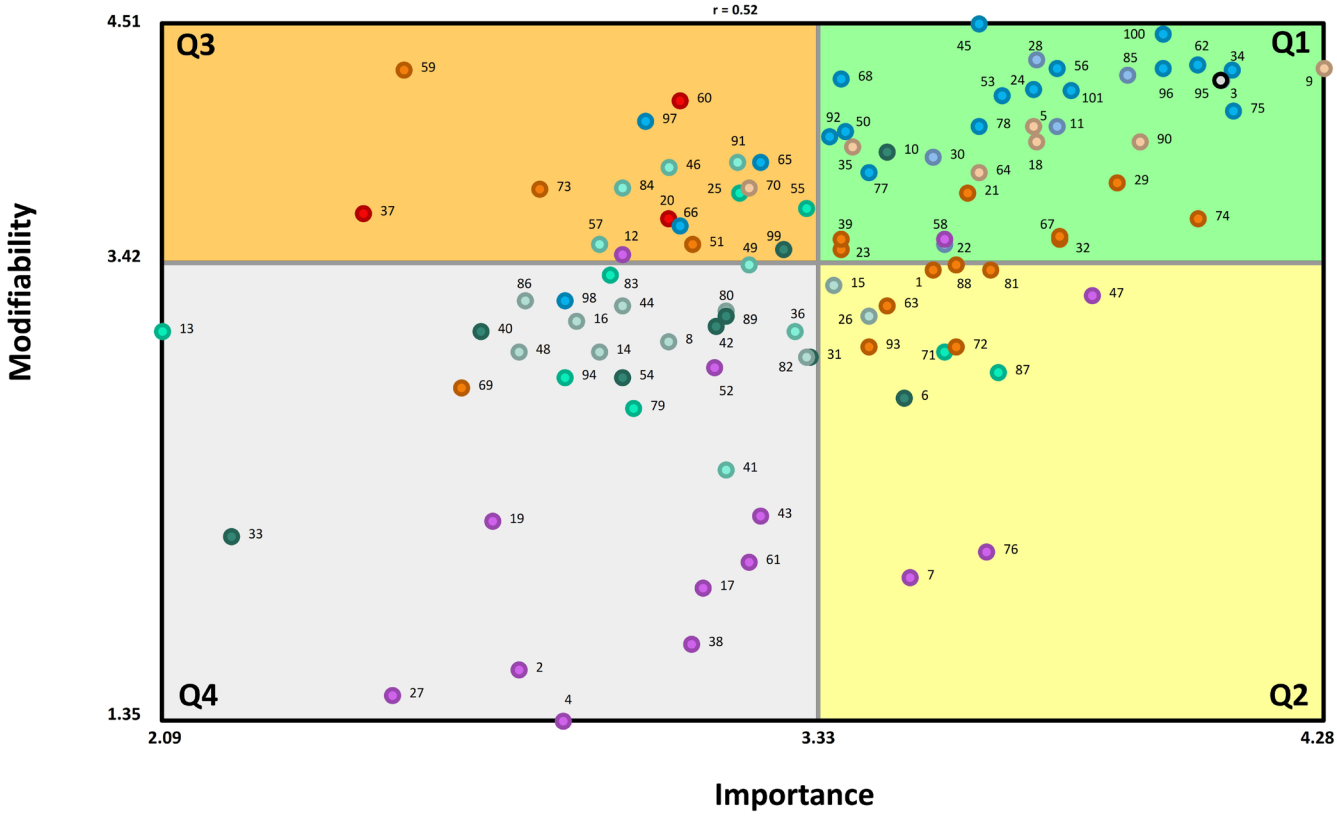


Figure 3 Ten-cluster map, divided into five higher-level domains of factors experts' perspectives on the gender- and/or sex-specific factors relevant to injury prevention for female, woman and girl athletes. Numbers refer to individual statements (see table 2 for details).



Cluster	
1. Inequitable organizational funding and support	7. Gendered expectations to conform to athletic ideals and norms
2. Athletes' lack of, and access to, resources	8. Gendered harassment (interpersonal violence) and social biases
3. Lack of knowledge and expertise among support staff	9. Gendered sport environment
4. Lack of evidence for and implementation of gender and sex-appropriate injury prevention	10. Gendered communication
5. Sex-related factors	Represents statement 3 (cluster 3) and statement 95 (cluster 5) due to identical mean ratings.
6. Gendered health	

Go-Zone quadrants	
Q1	Statements rated above the grand mean for importance and modifiability
Q2	Statements rated above the grand mean for importance and below grand mean for modifiability
Q3	Statements rated below the grand mean for importance and above grand mean for modifiability
Q4	Statements rated below the grand mean for importance and modifiability

Figure 4 Go-Zone map of all statements based on participants' perceived relative importance and modifiability ratings for gender- and/or sex-specific factors that contribute to injury risk among female, woman and girl athletes.

important by community sport participants). The high versus middle- and low-income country of residence pattern match graph (online supplemental file 4) also demonstrated a similar order of importance ratings between groups, except for *gendered communication* (rated least important by participants from high-income countries and fifth most important by those from middle-income and low-income countries).

DISCUSSION

This study used a GCM approach to amplify experts' voices—athletes/coaches/carers, health, medical or exercise practitioner, administration and researchers—to better understand female/woman/girl athlete's perceived injury risk.[27 28] Participants identified multiple factors, grouped into 10 clusters within five domains: (1) Funding and resources; (2) Expertise and knowledge; (3) Sex; (4) Gendered environment and (5) Gendered communication (figure 3). Not only do these clusters and domains exist within a complex system, whereby action in one domain could impact others, they also span individual, interpersonal, community/sport and society ecological levels, highlighting the concerted multilevel, broad approach required to reduce female/woman/girl athlete injury (figure 1).

Importantly, the statements, clusters and domains reflect the lived experiences, expertise and beliefs of our study participants. Despite our best efforts to be inclusive, participants are mostly white, from high-income countries and identify with the same gender as the sex they were assigned at birth (cisgender). Therefore, the statements, clusters and domains might differ if our sample included more participants from lower income countries or different cultural and religious settings where the intersection of gender norms, socioeconomic status, ethnicity and limited healthcare access create additional barriers to injury prevention.[39 40] Similarly, our results may not be specific to female/woman/girl athletes participating in Para sports or gender diverse athletes. Acknowledging these limitations, we discuss the five domains below and suggest some practical actions.

Funding and resources

Critical to reducing inequities for female/woman/girl athletes,[41 42] this domain could influence many factors identified

by participants across multiple clusters and domains. Funding for injury prevention among female/woman/girl athletes lags behind that for male/man/boy athletes, with this inequity attributed to multiple factors (eg, less sponsorship, less media attention).[43] Poorly prioritised financial support, manifesting as inadequate infrastructure (facilities, equipment, protective equipment, training and competition planning), insufficient/inequitable pathways for adolescent girl athletes[44] and inferior access to experienced support staff,[45–47] could increase injury risk across many levels (figure 1). Inequitable funding and resources disproportionately impact female/woman/girl athletes with disabilities, of diverse racial/ethnic backgrounds, gender identities or from lower resourced countries or communities. Insufficient financial and/or organisational support also drives female/woman/girl athletes' part-time status, contributing to less time dedicated for injury prevention, training or recovery activities and limited support for athletes who are caregivers. The data also link individual athlete and interpersonal factors to injury risk through limited access to support personnel (eg, strength and conditioning practitioners, nutritionist, physiotherapists) with gender/sex-specific expertise (eg, menstrual cycle, pregnancy, post-partum, breast health).

All participants and subgroups (elite/community; high-income/middle-income and low-income countries) rated the clusters in this domain as relatively important and modifiable. This suggests that how female/women/girl's sport is funded and organised at local, national, regional and international community levels could be an impactful starting point for action and change across the range of clusters and domains identified in this study. Participants may have considered that making financial and organisational decisions to equitably distribute funds is possible—requiring leaders from community/sport organisations and government to dismantle gendered norms, biases and expectations that disadvantage female/woman/girl athletes.

Example actions: mandate equitable injury prevention investment targets and gender balanced sports governance structures and bodies (eg, https://repub.eur.nl/pub/77568/Metis_205453.pdf),[48] providing staff and support personnel with specific training and expertise for female/woman/girl athletes, and normalise considering whether gender/sex-specific equipment, uniforms or footwear are necessary, without assuming difference.

Expertise and knowledge

This domain aligns with two known barriers to effective implementation: lack of female/woman/girl injury prevention evidence and/or inability to access/action available evidence.[49 50] These findings are consistent with the FAIR consensus systematic and scoping reviews[10–12 51] and rated among the most important and modifiable factors contributing to female/woman/girl athletes' injury risk. Participants also identified multiple understudied factors that might influence injury risks among female/woman/girl athletes, including body weight/composition, technical skills/ability, menstrual experiences, hormonal profile, contraception use, maturation/training age, muscle function (strength/power, etc), training pre and post-partum, recovery and pelvic and breast health. Evidence and/or implementation gaps were also noted regarding training methods for female/woman/girl athletes to prevent injury—for example, how to build strength, train technical skills (eg, tackling, falling) and implement injury prevention interventions.

Example actions: prioritise research funding to enable high-quality studies to investigate evidence and implementation gaps related to female/woman/girl sport injury prevention, for all abilities, ethnicities, races, cultures and economies. Such funding should accompany changing priorities within research teams, institutions and publishers to support, generate and share accurate evidence accessibly (eg, no pay-wall and in lay language) to those who interact with female/woman/girl athletes.[52 53]

Creating and disseminating evidence-based information to enhance and support the knowledge of athletes, and coaching, health, medical and other support staff is essential to address the inadequate access/delivery of evidence-based and best-practice injury prevention. This requires the involvement and support of decision-makers within local, national, regional and international communities and sport systems (figure 1) to disseminate resources, allocate time and prioritise female/woman/girl athletes' health and safety.

Sex

This domain contains a tight knit cluster of '*Sex-related factors*' focused on the unique biological, anatomical and physiological characteristics of female/woman/girl athletes despite insufficient evidence supporting them as relevant risk factors. For example, participants perceived hormones, including monthly fluctuations, life-stage changes and exogenous administrations to influence injury risk, despite little evidence confirming these associations.[54 55] This was the only cluster rated higher for importance than modifiability with only one statement (58: neuromuscular control) in Q1 of the Go-Zone. While participants grouped these factors into a 'sex' domain, many circumstances such as athletes' socioeconomic experiences (eg, access to appropriate training and stereotypical play) can influence factors like anatomy or movement patterns. Recognising and respecting female-specific biology is important at the athlete/individual level (figure 1), but disentangling gender and sex factors may be too simplistic.

Example actions: focusing solely on sex-related factors might not be the worthiest target of injury prevention efforts. Research teams evaluating sex-related factors must carefully identify and consider which biological (sex) and/or sociocultural (gender) aspects are relevant to the research question, with an urgency to accurately collect and report female/woman/girl-specific (disaggregated) data.[9]

Gendered environment

This domain considers injury risk through a gendered lens. Gender refers to socially constructed characteristics including norms, values, behaviours, roles and interactions with each other and others—its meaning is influenced by individuals' experiences, cultures, societies and economics and varies over time and across contexts.[56] Four related clusters situate injury risk within the environments where female/woman/girl athletes live, work, study and play sport: (1) gendered health, (2) gendered expectations to conform to athletic ideas and norms, (3) gendered harassment (interpersonal violence) and social biases and (4) gendered sport environment. The gendered environment has been described previously in sport contexts[57] and introduced to injury prevention in 2020–2021.[14 58] Participants' contributions in this domain include items not typically thought to influence sport injury risk. This creates opportunities for various injury prevention solutions, across socioecological levels (figure 1).

Gendered health: this cluster suggests that perceptions of female/woman/girl health—for example, hormonal fluctuations or fear of reinjury, make them 'weak' and injury prone or menstrual cycle stigmas—might limit injury prevention offerings. For female athletes who bear children, lack of support before,

during and after pregnancy was also perceived to heighten injury risk. Participants also described some conditions in female/woman/girls, including attention-deficit hyperactive disorder, poor sleep quality, disordered eating, which may be underdiagnosed and/or overlooked and influence injury risk or recovery.

Gendered expectations to conform to athletic ideals and norms: female/woman/girl athletes must navigate important and sometimes diverging expectations when participating in sport. Strategies to meet masculine norms of aggression, risk-taking, over-training and not wanting to appear weak, might increase female/woman/girl athletes' injury risk. For example, overlooking and under-reporting injuries is widespread in female/woman/girl sport and commonly reinforced by teammates.[59] While striving for ideal body size and composition, female/woman/girl athletes might resort to unhealthy behaviours that negatively impact performance, health (eg, Relative Energy Deficiency in sport, eating disorders, disordered eating) and elevate injury risk.[54] Our data did not represent the perception of female/woman/girl athletes being 'fragile and dainty',[60] which could result in overprotective behaviours and diminished exposure to injury prevention activities.

Gendered harassment (interpersonal violence) and social biases: female/woman/girl athletes experience and are negatively affected by interpersonal violence (gender-based and other forms) more than male/men/boy athletes[61]; even more so for those who experience intersectional discriminations.[62] These experiences have consequences, including higher average scores for depression and eating disorders,[63] and for injury/illness prevalence.[64] Sexist behaviours, gendered harassment and/or social biases for female/woman/girl athletes to be caregivers and prioritise team harmony stop them from accessing and receiving best-quality injury prevention and treatment opportunities. Society's biases for female/woman/girl athletes to have different exposures and expectations (eg, avoiding rough or risky play, not being powerful or physically strong) can influence individual physical development (eg, muscle strength, movement patterns, safe falling), subsequently impacting future injury risk.

Gendered sport environment: across many sports, female/woman/girl athletes have not had opportunities to participate in comparable numbers or at equivalent competitive levels for the same length of time as male/man/boy athletes. Consequences of less mature competition and training sport environments include lesser and lower intensity training and competition, such as fewer pathways to elite programmes or insufficient talented and experienced players to compete against. When combined with inappropriate game/fixture scheduling, poor access to facilities, and increases in game intensity and skill requirements,[65] greater loads (physical, psychological and social) are placed on athletes who are less prepared to withstand them. Other factors such as intimidation in male-dominated gyms and expectations that female/woman/girl athletes are less competitive or more likely to drop out following injury might discourage female/woman/girl athletes from completing injury prevention and recovery activities.

Example actions: deliver interventions aimed at enhancing athlete's confidence and ability to participate in traditionally male/man/boy activities (eg, tackling and falling). Coach accreditation programmes could include female/woman/girl athlete-specific information to promote health (eg,https://www.ais.gov.au/fphi/education). Deliver injury prevention activities at times that are conducive to those with families/caring responsibilities, including online activities. Mandate codes of practice regarding inclusion and equity; invest in developing female/woman coaches and leaders. Leverage media to improve portrayal of female/woman/girl injuries. Create policy and strategy, and/or take action to eliminate interpersonal violence against female/woman/girl athletes.

Gendered communication

This single-cluster domain, sitting at the centre of our cluster map, influences and intersects with all clusters, highlighting the need for a gendered approach to discussing injuries, injury risks and officiating with female/woman/girl athletes. The statements were considered relatively less important, but more modifiable than most other clusters. Combined with its central, influential position, the perceived modifiability of this domain suggests that efforts to understand and enhance how gendered communication impacts injury risks and injury prevention for female/woman/girl athletes should be taken seriously.[66]

Example actions: prioritise training and resources (particularly around different communication needs of female/woman/girl athletes), select support staff with experience working with female/woman/girl athletes, focus on athlete-centred communication and consider gender-sensitive and inclusive language for resources and education (eg, for coaching tackling and troubleshooting breast tenderness). Prioritise context- and culture-sensitive training for those involved in injury prevention (eg, appropriate use of female/woman, and inclusive language for gender-diverse individuals). Female/woman/girl athletes should cocreate such training programmes.

Gender/sex considerations in injury prevention

Reinforcing the integrity of our findings is their alignment with the five gendered environment themes presented by Coen and colleagues' in their study of retired elite women athletes lived experiences in the United Kingdom[67] (with divergences reflecting different populations, study questions and study designs). Coen *et al*'s *'Stereotypes trivialise injury'* challenge and our '*Gendered health'* cluster describe similar constructs related to injuries and health concerns being trivialised and ignored, which can increase athletes' injury risk and consequences. Their *'Physiology is all or nothing'* challenge aligns with our '*Sex-related factors'* and '*Gendered sport environment'* clusters, with all describing a mismatch between sex and gender. Their *'Ideal' female athlete'* challenge overlaps with our '*Gendered expectations to conform to athletic ideals and norms'* and '*Gendered communication'* clusters. One difference is that participants in our study focused more on communication by others *with* the athlete, rather than the constrained communication of the athletes themselves. Their *'In/visible inequities'* challenge had many similarities with our '*Funding and resources'* domain, describing inadequate organisational support, funding and access across all socio-ecological levels. Their *'In/visible inequities'* theme also intersected with our '*Gendered harassment (interpersonal violence) and social biases'* cluster, with both highlighting the worrying and pervasive sexist behaviours that increase female/woman/girl athletes' cognitive load, disrupting their access to best-practice injury prevention. Finally, their *'Uneven power dynamics'* aligns closely with elements of our *'Athletes' lack of, and access to, resources'*, '*Gendered expectations to conform to athletic ideals and norms*' and '*Gendered communication*' clusters. While Coen *et al*'s lived-experience-of-injury lens prioritised providing healthy and safe sport environments, participants in our study (when asked to apply an injury prevention lens), focused on a lack of access to gender-appropriate and/or sex-appropriate resources for female/woman/girl athletes.

Strength and limitations

By engaging participants from six continents across the five categories of the closeness continuum, we captured a broad range of perspectives relevant to injury prevention for female/woman/girl athletes reflecting lived experiences, professional expertise and systemic considerations. Our author group, which had representation across six continents, research career stage and sport expertise, strengthened the interpretation and contextualisation of these data, ensuring the findings are grounded in academic rigour and practical relevance. Despite targeted efforts to recruit participants broadly and inclusively, we acknowledge that most of the author group and participants were white and from high-income countries. All participants identified with the same gender as the sex they were assigned at birth (ie, cisgender). As the perspectives of gender diverse (eg, transgender, non-binary), individuals are not represented in this study, our findings' have limited applicability to sports injury risk beyond a cisgendered experience. Many groups/ethnicities were under-represented, limiting the generalisability and external validity of the results to all sporting or cultural contexts. For example, there was only one statement regarding gendered clothing (#33). Future studies could test the external validity of our findings and gain input on their relevance for participants from different settings (eg, from low-income countries or from cultural and religious settings where the intersection of gender norms, socioeconomic status, ethnicity and limited healthcare access create additional barriers to injury prevention) and with greater gender diversity/representation of non-cisgender identities.

We also acknowledge that choosing GCM as our research methodology may have impacted the findings of our study. The non-random sampling and reliance on researcher skill/experience in several GCM steps can reduce the reliability, validity or generalisability of findings.[68] This is particularly relevant given the active role the predominantly white and high-income author group played in the statement synthesis (step 2), statement representation (step 4) and interpretations of the maps (step 5). In addition, using English as the only language may have disrupted the meaning, interpretation or nuance of some statements by participants without English as their first language. However, we rigorously followed standard GCM methods,[30] and several research team members have extensive methodological training and experience (AD, AMB and MJH). We believe this offsets some of these limitations. This belief is supported by the similarity in order of the relative importance of nearly all the clusters between participants from high-income and middle/low-income countries (online supplemental file 4).

CONCLUSION

Participants identified 10 clusters, across 5 domains: (1) Funding and resources; (2) Expertise and knowledge; (3) Sex; (4) Gendered environment and (5) Gendered communication, which were considered to contribute to injury risk among cisgendered female/woman/girl athletes. Advancing stronger evidence for gender and sex appropriate injury prevention is urgently needed. However, reducing inequitable gender and/or sex injury risk in sport is easier said than done. A novel, collaborative and multilevel approach is required to reduce female/woman/girl athlete injuries and involves the prioritisation of research, leadership and policy from sporting organisations across all levels of sport. Sporting communities that influence female/woman/girl athlete health—including peers, family, coaches, practitioners, scientists and researchers, administration, media—can individually and/or collectively discuss and address the potential female/woman/girl athlete injury risk factors spotlighted in our study. A good starting point would be to focus on factors that were deemed to be most important and modifiable and adopt a comprehensive approach that spans the socioecological levels of influence. We can, and should, all do something.

Author affiliations
[1]Australian IOC Research Centre, La Trobe University, Melbourne, Victoria, Australia
[2]La Trobe Sport and Exercise Medicine Research Centre, La Trobe University, Melbourne, Victoria, Australia
[3]College of Sports, Health and Engineering, Victoria University, Melbourne, Victoria, Australia
[4]Department of Physical Therapy, Faculty of Medicine, The University of British Columbia, Vancouver, Washington State, Canada
[5]Arthritis Research Canada, Richmond, Virginia, Canada
[6]Schizophrenia Division, Centre for Addiction and Mental Health, Toronto, Ontario, Canada
[7]Department of Psychiatry, University of Toronto, Toronto, Ontario, Canada
[8]Western Centre for Public Health and Family Medicine, Schulich School of Medicine and Dentistry, Western University, London, Ontario, Canada
[9]International Olympic Committee, Lausanne, VD, Switzerland
[10]Program for Pregnancy and Postpartum Health, Faculty of Kinesiology, Sport, and Recreation, Women and Children's Health Research Institute, Alberta Diabetes Institute, University of Alberta, Edmonton, Alberta, Canada
[11]Department of Family Medicine, McMaster University Michael G DeGroote School of Medicine, Waterloo, Ontario, Canada
[12]Appleton Research Institute, Central Queensland University School of Human Health and Social Sciences, Rockhampton, Queensland, Australia
[13]Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation, Spaulding Hospital/Brigham and Women's Hospital, Harvard Medical School, Charlestown, Massachusetts, USA
[14]Department of Public and Occupational Health, EMGO, Amsterdam UMC Locatie VUmc, Amsterdam, The Netherlands
[15]Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada
[16]National Spinal Injury Referral Hospital, Nairobi, Kenya
[17]Kenya Ministry of Health, Nairobi, Kenya
[18]Amsterdam Collaboration on Health & Safety in Sports, Department of Orthopedic Surgery and Sports Medicine, Amsterdam UMC Locatie AMC, Amsterdam, The Netherlands
[19]Section Sports Medicine, University of Pretoria Faculty of Health Sciences, Pretoria, Gauteng, South Africa
[20]Hospital for Special Surgery, New York, New York, USA
[21]Sport Medicine, Shaare Zedek Medical Center, Jerusalem, Israel
[22]Centre for Sport Leadership, Maties Sport, Stellenbosch University, Stellenbosch, South Africa
[23]Federação Portuguesa de Futebol, Portugal Football School, Cruz Quebrada, Portugal
[24]Family and Community Medicine, Sports Medicine, University of Iowa Health Care, Iowa City, Iowa, USA
[25]Waseda University Faculty of Sport Sciences, Tokorozawa, Japan
[26]Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada
[27]Medical Education Department, Aspetar Orthopaedic and Sports Medicine Hospital, Doha, Qatar
[28]Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, Oxford University, Oxford, UK
[29]Centre for Sport and Social Impact, La Trobe University, Melbourne, Victoria, Australia

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ORCID iDs
Kay M Crossley http://orcid.org/0000-0001-5892-129X
Melissa J Haberfield http://orcid.org/0000-0002-6366-0896
Andrew G Ross http://orcid.org/0000-0003-4680-7419
Libby J Gracias http://orcid.org/0009-0007-2349-097X
Andrea M Bruder http://orcid.org/0000-0001-5422-5756
Jackie L Whittaker http://orcid.org/0000-0002-6591-4976
Araba Chintoh http://orcid.org/0000-0002-7775-5810
Jane S Thornton http://orcid.org/0000-0002-3519-7101
Margie H Davenport http://orcid.org/0000-0001-5627-5773
Margo Mountjoy http://orcid.org/0000-0001-8604-2014
Melanie Hayman http://orcid.org/0000-0003-1469-3496
Brooke E Patterson http://orcid.org/0000-0002-6570-5429
Cheri A Blauwet http://orcid.org/0000-0001-8568-1009
Evert Verhagen http://orcid.org/0000-0001-9227-8234
Carla van den Berg http://orcid.org/0000-0001-6429-4333
Carole Akinyi Okoth http://orcid.org/0009-0005-1187-4250
Dina Christina (Christa) Janse van Rensburg http://orcid.org/0000-0003-1058-6992
Ellen Casey http://orcid.org/0000-0003-0139-8826
Nana Akua Achiaa Adom-Aboagye http://orcid.org/0000-0003-2547-5005
Yuka Tsukahara http://orcid.org/0000-0001-6208-5060
Carolyn A Emery http://orcid.org/0000-0002-9499-6691
Alex Donaldson http://orcid.org/0000-0003-4764-2361

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