

Saddle sores among female competitive cyclists: a systematic scoping review

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Abstract

Background: Saddle sores are a prominent but under investigated health issue among female competitive cyclists.

Objective: To identify and describe existing evidence of the prevalence, prevention and treatment of saddle sores among female competitive cyclists.

Design: Systematic scoping review and expert consultation.

Methods: Primary studies and grey literature investigating the management of saddle sores for competitive female cyclists were identified from six databases which were systematically searched (Medline; PubMed; Scopus; SportDiscuss; Embase; Advanced Google Scholar) from 1990 onwards. An online survey was distributed to 16 consultants in the female Australian competitive cycling community.

Results: Of the 401 studies identified, 10 met the inclusion criteria – 4 were case-series, 4 were cross-sectional, and 2 were brief intervention trials. There was limited empirical evidence to determine the prevalence, and identify prevention and treatment approaches for saddle sores. Handlebar positioning relative to the saddle and reducing perineal pressure had some evidence. Saddle sore treatments appear to be limited to antibiotics and surgical intervention when they worsen or become infected. Yet, three-quarters of the consultants indicated saddle sores were frequent among female competitive cyclists, identifying prevention and management strategies as topical creams, maintaining good hygiene, wearing appropriate clothing, leg elevation and taking time off the bike.

Conclusion: There is limited research investigating the prevalence, prevention and treatment of saddle sores among female competitive cyclists, although it has been described as a common occurrence by those in the Australian cycling community. Robust research is required to understand its prevalence and identify effective prevention and management methods.

Keywords

Saddle Sores; Competitive Cycling; Sports Medicine; Sports Injuries; Bicycling; Female Athletes; Folliculitis; Skin Diseases

Practical implications

- This review summarises evidence of the prevalence, prevention and treatment of saddle sores among female competitive cyclists.
- Limited empirical evidence was identified on saddle sore prevalence, yet the cycling community consultants reported saddle sores as common among this population.
- Currently, there is limited empirical evidence to support the saddle sore prevention and treatment methods. There is a need for data on saddle sore prevalence and robust studies to trial prevention and treatment methods.

1.0 Introduction

Saddle sores are a commonly reported injury among recreational and competitive female cyclists, who spend long periods of time on bicycles engaging in training regimes [1, 2]. Broadly, saddle sores are described as a skin ailment most frequently occurring on the buttocks, groin and inner thigh [3]. The development of saddle sores usually begins with mild chafing [1] and perineal pain [4], extending to skin infections, ulcerations and folliculitis if symptoms remain untreated [3].

These injuries are often attributed to anatomical features, as women have broader hips and thighs than men, affecting the saddle pressure distribution and increasing the risk of injury near the perineum [5]. However, it is also influenced by the intensity and riding style which determines the pressure, sweat, and friction of the saddle area [3]. In addition, incorrect saddle fit can result in increased compression of the perineum and neurovascular compromise [6].

Poor management of saddle sores may extend beyond pain and infection to impacting female sexual health and urinary function [4]. Genital numbness, vulva hypertrophy, urinary tract infections and severe lesions can develop from infected skin ulcerations [3, 4, 7, 8]. Female cyclists who present with these symptoms may require surgical intervention even though there is limited evidence of its effectiveness, with some symptoms reoccurring after surgery [9]. This may affect women's prospects of returning to cycling, especially for those who participate in competitions.

Possibly due to the sensitivity of this health issue, there appears to be a lack of empirical evidence related to the management and treatment of saddle sores with most information reported anecdotally [10], and through popular cycling websites. While online resources can reduce barriers to access health information about sensitive issues such as saddle sores, for female cyclists, the credibility of this information is largely unknown, and may pose risk of further harm. Of the anecdotal evidence, there appears to be a wide consensus that cyclists should use a combination of individual and mechanical strategies to prevent and treat saddle sores.

Reported strategies to prevent saddle sores include altering saddle design, cushioning and cycling technique, wearing high quality bike shorts (chamois), as well as using lubricants to mitigate seat friction, maintaining high personal hygiene and removing pubic hair [11, 12]. Taking a break from riding was commonly cited as a treatment for saddle sores, followed by applying cold or hot compressors, using antibiotics, over-the-counter anti-bacterial, anti-fungal and steroidal creams, and wearing loose and breathable clothing [11-15]. While most of these strategies were repeatedly mentioned online, information relating to the effectiveness of these methods were limited to commentary shared by individual cyclists, reinforcing the challenges around the ability of female competitive cyclist to manage saddle sores.

To our knowledge, the prevalence of saddle sores and their prevention and treatment among female competitive cyclists is largely unknown, with most information being anecdotal [10]. Most studies have reported clinical symptoms of saddle sore related outcomes that require surgical intervention, rather than management of early signs and symptoms [9, 16, 17]. Strengthening the knowledge base in these areas can be used to better inform health professionals, coaches and female cyclists in how to manage saddle sores and prevent the development of more severe saddle-related injuries. This scoping review investigated the prevalence, prevention and treatment methods for saddle sores among female competitive cyclists.

2.0 Methods

2.1 Protocol and registration

A protocol for this review was developed using the Joanna Briggs Institute Reviewers Manual [18] and can be accessed via contact with the authors. This manual is derived from Arksey and O'Malley [19] methodological framework which was advanced by Levac,

Colquhoun [20]. This study included the optional consultation stage. The review protocol was developed by the academic staff in the School of Public Health and was registered with the Joanna Briggs Institute[21].

2.2 Eligibility criteria

2.2.1 Population of interest

This review considered texts including primary studies (quantitative or qualitative) and grey literature. The population of interest were female competitive cyclists.

2.2.2 Concept

The key concept of interest is the prevalence, prevention and treatment of saddle sores among female competitive cyclists. Identified search terms used to capture relevant literature included 'saddle sore', 'chafing', 'boil' and 'vulva'.

2.2.3 Context

The review considered texts relating to competitive cycling. Texts from recreational cycling, horse-riding and non-sport related studies were not included.

2.2.4 Types of studies

The review included all texts that met the inclusion criteria for the population of interest, concept and context including primary studies (qualitative or quantitative) and grey literature. Texts were included from 1990 onwards and all geographical regions; and in any language provided an English translation could be obtained.

2.2.5 Inclusion and exclusion criteria

Texts that mentioned saddle sores or linked saddle sores to other injuries and illnesses; had female population; and involved competitive and competitive recreational cyclists (or did not mention type of cyclist) were included for this review. Texts were excluded from the review if they were secondary reviews of the literature; if they reported only anecdotal evidence; if they reported only on a male population; or if the population was involved in light recreational and commuter cycling.

2.3 Information sources

The Health Sciences faculty librarian assisted in the design of the search strategy identifying five databases (Embase, Medline, PubMed, Scopus, SportDiscuss, advanced Google Scholar). An analysis of the Medical Subject Headings (MeSH) and keywords from

texts retrieved from a preliminary search across three databases were used to define the initial search terms. The second search across the five databases and advanced Google was conducted in December 2018 and updated in December 2019. The search was not limited by date, region or language.

2.4 Search

The search terms for inclusion in this review were:

- *cycling, cyclist, bicycle, bike; AND*
- *saddle sore*, chafing, boil, vulva, genital.*

2.5 Selection process

Records were assessed using the inclusion criteria at each stage of the review. Two reviewers (KB, CL) consulted in each stage of the process, and third and fourth reviewers (JL, JJ) were involved in selecting papers for the full text review. EndNote software [22] was used to manage records by creating groups to filter records throughout the selection process starting with importing all records from the database search into an EndNote library [23]. Duplicate records were removed to create a sub-group housing only unique records. The titles and abstracts were screened using the inclusion criteria to create a group to be screened for eligibility using the full text. Following the final screening, this group was split into groups for inclusion and exclusion. A snowballing approach was taken, to retrieve additional texts through hand-searching the citations and reference lists of key texts from the original search. This filtering of records through the selection process is illustrated in a PRISMA flow diagram. The authors of publications that appeared to meet the inclusion criteria were contacted in instances where the full text was not available online.

2.6 Data charting process

The final selection of texts to be included were charted using the following data:

- 1. Author and year*

The last name of the authors as per the citation and year of publication as per the citation.

- 2. Study Population*

Describes the study population in terms of gender and style of cycling.

- 3. Study design*

Identifies the study design or if unclear, the reviewers' description of the methodology.

4. *Limitations*

Describes limitations of the study

5. *Aim*

Identifies the aim or purpose of the text or if unclear, the reviewers' definition of the aim.

6. *Outcome measures*

Identifies the outcome measure if applicable to the study design.

7. *Measures*

Describes the data collection method i.e.: survey, examination.

8. *Prevalence*

Describes evidence for the prevalence of saddle sores and/or related symptoms.

9. *Prevention*

Describes evidence for the prevention of saddle sores and/or related symptoms.

10. *Treatment*

Describes evidence for the treatment of saddle sores and/or related symptoms.

11. *Recommendations*

Summarises data and makes recommendations

2.7 *Synthesis of results*

For each of the selected texts or documents, the reviewers identified evidence describing saddle sores or related symptoms among female competitive cyclists. This was recorded initially in the terms of the author, if this approach was not named by the author, it was described succinctly by the reviewer. Evidence was charted according to the description of the evidence described by the author/reviewer (Table 1) and was described according to evidence for prevalence, prevention and treatment. These groups were described using a narrative approach.

2.8 *Consultation stage*

Consultants were required to be stakeholders from the Australian cycling community who were female cyclists or worked with female cyclists. The consultation was conducted via an online survey and aimed to validate the findings of the scoping study and elicit additional insights for the review and guide recommendations for future research. A snowballing

recruitment method was used to recruit consultants for the survey with initial consultants sourced through the Australian cycling community and LinkedIn. The online survey started with a general question exploring respondent's knowledge of saddle sores and perception of the prevalence of saddle sores among competitive female cyclists. It went on to explore awareness of prevention and treatment methods for saddle sores and the perception of their effectiveness. Respondents were asked if they sourced information from others, and who they sourced it from, and then given an opportunity to provide further comments on saddle sores. Human Research Ethics Approval (number 2019-0120) was obtained from XXXX University.

The data were analysed using descriptive statistics. Consultants reported the effectiveness of saddle sore treatments on a five-point Likert scale, which was dichotomised (effective 1-3: ineffective 1-2). Open ended questions, were recorded and quotes were used to support findings related to prevalence, prevention and treatment of saddle sores. Demographic characteristics were collected (age, sex, role in cycling community, years worked).

4.0 Results

4.1 Selection of evidence

The search strategy (see Appendix I) identified a total of 401 records across the five databases (see Figure 1). After duplicate sources were removed, a total of 301 remained and a further 5 unique records were added following a hand search of the references and citations of key papers. A total of 306 records were screened for eligibility using the title and abstract from which 74 records were selected for full text review (232 records excluded). Following the full text review, 64 records were excluded for reasons including; not being a primary study; or for not meeting the inclusion criteria for context or concept. Finally, 10 records were selected for inclusion in the review. The 13 studies that could not be obtained were predominantly published in the popular press (n=12) with one a peer reviewed publication.

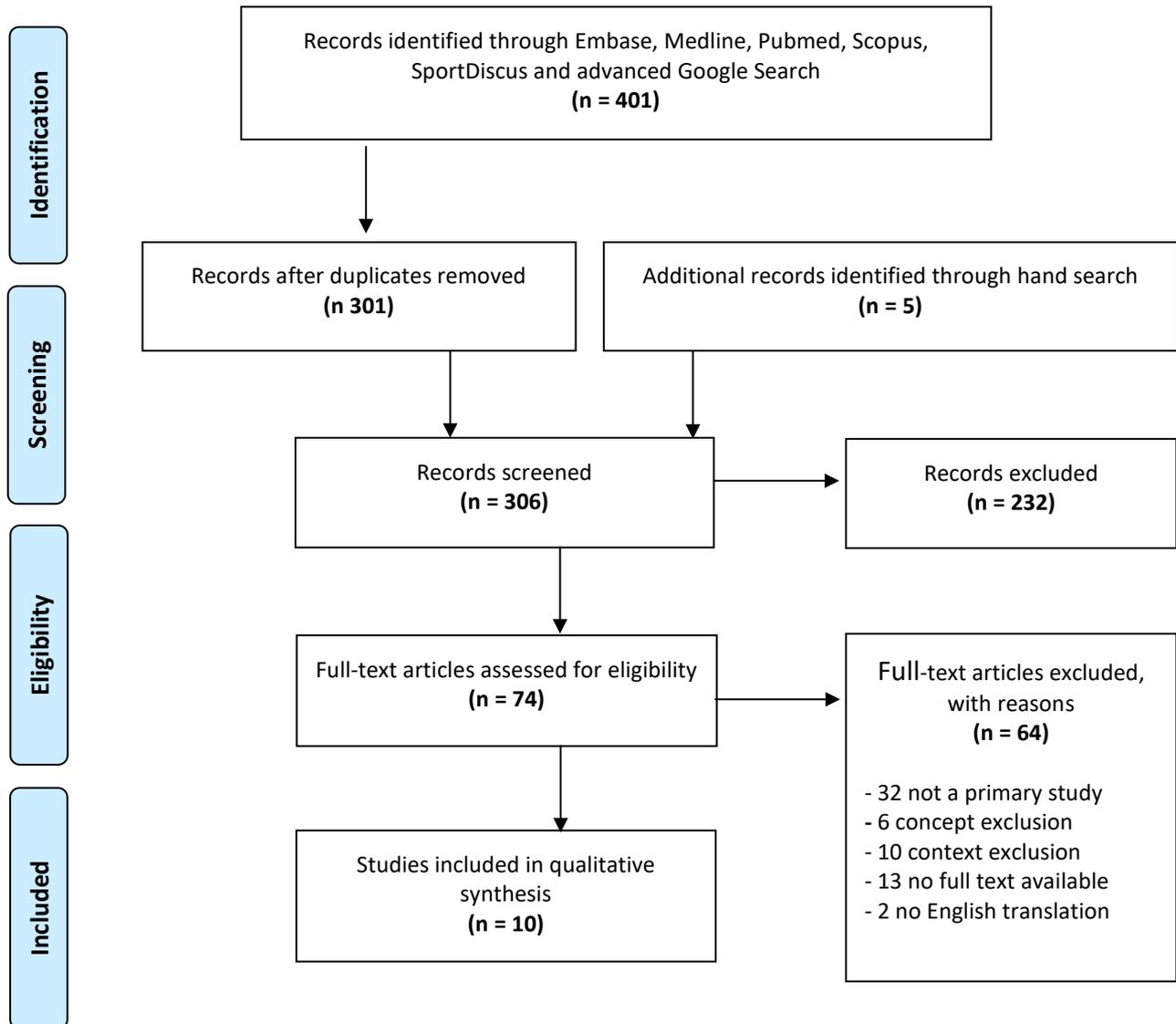


Figure 1: PRISMA Flow Diagram [24] of study selection and inclusion process

4.2 Characteristics of evidence

The 10 studies have been summarised in Table 1.

(Insert Table 1 here)

5.0 Consultants

The consultants were predominantly female (n=9), aged 18 to 49 years, who had spent more than five years (n=13) working in the Australian cycling community (see Table 2)

Table 2. Consultant demographics (n=16)

Sex	n	%
Female	9	56
Male	7	44
Age (years)		
18-29	7	44
30-39	6	38
40-49	3	19
Place of residence		
Australia	15	95
Traveller (worldwide)	1	5
Role in cycling community*		
Competitive cyclist	6	38
Coach	5	31
Health professional (sport scientist, physiotherapist, doctor)	5	31
Cyclist	2	13
Bike fitter	2	13
Researcher	1	6
Years worked with cyclists		
< 5 years	3	19
5 to 9 years	7	44
> 10 years	6	38
Sex of cyclist work with		
Female	5	31
Both	11	69

*some consultants mentioned more than one role (n=21)

The survey revealed that the definition of saddle sores varied widely among the consultation group. Saddle sores were described as being skin irritations of varying severity, ranging from inflamed skin and abrasions to chafing, cuts, swelling and bruises.

“I know that saddle sores can come in a range of forms, from cuts to lumps, pressure sores or swelling.” (Consultant 5)

“..creating lumps that are very painful. They can become bruises.”(Consultant 6)

More severe cases of saddle sores were described as infected skin and hair follicles, and cyst-like bumps and boils.

“Inflamed skin or a skin infection on the perineum in cyclists. Either acute or chronic.” (Consultant 2)

“They range from red, chafing type friction sores which can bleed and ooze on the surface to small round lumps deep under the skin.” (Consultant 8)

“They are broken skin/infection/infected hairs in the perineum that can become boils/connective tissue build up, space occupying lesions.”(Consultant 12)

However, the cause of saddle sores were consistently reported to occur on areas of the skin in contact with the bicycle saddle. Consultants described saddle sores as occurring as a result of to “rubbing,” “friction,” “pressure” and “long-durations of riding.” Specific areas identified were the perineum, thighs, groin and buttocks, but varied depending on the cyclist, as one respondent reported:

“I usually discuss saddle sores in two forms, such as a friction issue or a pressure issue.” (Consultant 1)

“They happen on the groin area, or on your butt, depending on who you are and where the saddle comes into contact with your undercarriage.” (Consultant 14)

5.1 Prevalence

When unprompted, most consultants recognised saddle sores were prevalent among competitive cyclists, and two consultants also stated that saddle sores occurred among triathletes and horse riders. All consultants were aware of saddle sores among female competitive cyclists and reported that they were common.

5.2 Prevention

All consultants reported at least three or more methods to prevent (see Table 3) and treat (see Table 4) saddle sores and ranked their perceived effectiveness. The most frequently identified methods aimed at preventing saddle sores were using a chamois, altering saddle position and having meticulous personal hygiene. Of these methods, 87% of consultants found the saddle position and meticulous personal hygiene to be effective, while others (81%) nominated the use of a chamois. One consultant advised avoiding the removal of pubic hair and using a female specific chamois. Another believed maintaining personal hygiene did not prevent the occurrence of saddle sores but may prevent a wound from becoming infected.

Saddle design was also perceived as an effective prevention method. The consultants particularly referred to risk of increased perineal pressure from incorrect saddle type and fit: *“Poorly fitting saddles - too narrow not allowing the sit bones to weight bear across the saddle, leading to perineal weight bearing. Too wide through the gusset of the saddle - correct sit bone width, but nose is too wide.”* (Consultant 3)

“Certain saddles were more or less forgiving with some causing acute issues...in hard training blocks where the volume or intensity is high, these two modes of training tend to force adaptations in posture and or position which can bring on saddle sore symptoms.” (Consultant 1)

Two consultants identified elevating the lower limbs after cycling, and one mentioned cream as helping, while also suggesting that the avoidance of creams might toughen the skin: *“There are products that act to reduce the risk of saddle sores, such as cream that reduce friction. Some cyclists prefer not to use the creams, in an attempt to 'harden' the skin to prevent saddle sores from occurring.”* (Consultant 5)

Table 3. Prevention methods and perceived effectiveness for saddle sores (n=16)

Prevention method	Aware of method		Perceived as effective	
	n	%	(n)	%
Using a chamois	16	100	13	81
Altering saddle position	15	94	13	87
Meticulous personal hygiene	15	94	13	87
Applying creams	14	88	12	86
Changing saddle design	14	88	12	86
Washing cycling gear straight after each use	14	88	12	86
Removing garments after cycling	13	81	12	92
Staying off the bike	11	69	11	100
Changing the amount of saddle cushioning	10	63	8	80
Altering handle bar position	9	56	6	67
Cycling technique	2	13	2	100
Elevation of lower limbs after ride	2	13	1	50

5.3 Treatment

Most consultants identified a treatment method for saddle sores, with antibiotics and surgery the most commonly reported treatments. Almost all consultants perceived these treatments as effective. However, there appears to be limited knowledge of other treatment methods due to their varied presentation. For example:

“I think mostly it comes down to the individual - everyone’s different under there. Some people don’t get them at all... others do... I don’t do anything to “treat” the sores - they go away with time.”(Consultant 14)

“Currently, it is very hard for women to find information regarding what a saddle sore even is, yet alone how to treat them!”(Consultant 10)

One consultant acknowledged the importance of focusing on prevention rather than treatment because of duration to recovery:

“Prevention and unloading the area is the most effective way of addressing saddle sores. Once you have them, you have to allow the skin to heal” (Consultant 3)

Table 4. Treatment methods and perceived effectiveness for saddle sores (n=16)

Treatment methods	Aware of method		Perceived as effective	
	n	%	n	%
Antibiotics	13	100	12	92
Surgery	9	69	9	100
Sitz bath	2	15	2	100
Cold compresses	3	23	2	67
Warm compresses	1	8	1	100
Rest from bike	1	8	1	100

5.4 Sources of information

Over two-thirds of the group had sought additional information about saddle sores. Most consultants asked other cyclists (n=9), doctors (n=7), coaches (n=4) searched websites (7) and consulted magazines and peer reviewed articles (n=3).

6.0 Discussion

This review aimed to investigate the prevalence, prevention and treatment of saddle sores by scoping the literature and surveying 16 consultants who were stakeholders from the cycling community. The consultation process aimed to validate the findings of the scoping review and elicit additional insights, to understand the issue and potentially inform recommendations for future research

The available literature was limited, with only 10 studies meeting the inclusion criteria. Four of these were case studies with small samples ranging from four to eight participants [16] (n=6), [17] (n=4) [25] (n=4), [9] (n= 8). Four studies were cross sectional, once again with small sample populations (n=41 to 63) [6] (n=48), [26] (n=63), [27] (n=41), (n=409) and two were small trials [28] (n=65), [29] (n=6)). The limited literature does not seem to reflect the pervasiveness of saddle sores in the cycling community, as all of the review consultants were

familiar with saddles sores, with three-quarters reporting them as common among women cyclists.

The saddle sore symptoms documented in the literature ranged from acute chaffing and bruising, painful saddle bones, and loss of sensation in pelvic area [28-30], to chronic unilateral labia swelling/hypertrophy [9, 16, 17], vulval nodule or swelling, urogenital injury and sexual dysfunction [26]. The descriptions of saddle sores provided by our consultants mimicked that in the literature, with chafing, infected skin, swelling, bruising, cyst like lumps and boils reported as occurring on the perineum, thighs, groin and buttocks.

The consultants reported that saddle sores were due to ‘rubbing’ ‘friction’ and ‘long-duration riding’, reasons all supported by the literature. For example Baeyens and colleagues [16] reported that saddle sore symptoms were more severe with longer duration rides but also speculated that saddle position, type of bicycle short (chamois) and hygiene were critical contributing factors, although there was no objective evidence to support these reported findings. Yet, bicycle design, such as handle bar height [30] and saddle shape and position [6, 9, 27, 29] were the most frequently nominated premise for saddle sores with four of these studies reporting a positive impact on saddle sore symptoms through altering design [6, 27, 29, 30]. This has stimulated increased developments in saddle designs with one particular cut out saddle becoming increasingly popular among women, although there is no evidence to support its use [6]. Unfortunately, the lower position of handlebars (than the saddle) is favourable for competitive riding as it improves aerodynamics, yet this positioning is at odds with the most ergonomic set-up for preventing injury in female cyclists [27].

The consultants most frequently nominated saddle position and meticulous personal hygiene as prevention methods and also recommended the use of chamois and creams. However, only one of the identified studies reported an improvement in saddle symptoms from using creams, and this study design was weak as there was no comparison group [28]. This lack of robust evidence was further highlighted by the consultants’ nomination of other cyclists as the main source of saddle sore information, indicating a need for evidence informed recommendations/guidelines for prevention and treatment.

It has been suggested that chronic saddle sores result from a culmination of acute symptoms over time which indicates the need for early identification and management to prevent

increased harm. For example, vulval hypertrophy was thought to result from repeated micro-trauma from vibrations, pressure and poorly fitted seats [17, 25], although the findings are largely speculative. Suggested treatments include physiotherapy to stimulate lymph drainage [16], applying cold packs and elevating legs to reduce swelling [9, 16]. However, chronic saddle sores can be incapacitating, requiring antibiotics and at times surgical intervention for cosmetic reasons and pain relief [9]. These are invasive and potentially short-term treatments.

The authors of the identified studies all recognised the need for further research into women cyclists, focussing on bicycle fit [27] and investigating a range of cycling practices so as to understand the impact of saddle design and saddle pressure [6]. There is a demonstrable call for randomised controlled trials and longitudinal prospective studies [6, 17, 28, 29] focusing on women so that the issue can be understood and findings able to be generalised.

Strengths and limitations

As far as we are aware this is the first review on saddle sores. The review identified a limited number of studies with small samples size and limited study designs. The majority of recommendations for the management of saddle sores were not generated by study findings but rather hyperbole. A strength of this review was the consultation stage. Although originally an optional stage [19, 20] argued that it added methodological rigor and should be a required component of a scoping review. This stage contributed additional sources of information, perspectives and meaning to the results.

7.0 Conclusion

This is the first review to be conducted on saddle sores among female competitive cyclists. The identified studies were underpowered, at times having a less than ideal designs (many were case studies), which were inconclusive and non-generalisable. There was limited evidence to support the suggested management approaches which included the use of topical creams and specially designed clothing, maintaining good hygiene, leg elevation, and time off the bike, which is often not feasible for competitive cyclists. There is some evidence to support reducing perineal pressure through altering bicycle design of the saddle and handlebars. However, to provide evidence informed recommendations to the female cycling community on the prevention and management of saddle sores, robust research is required.

Saddles sores were reported by the consultants as common among female cyclists emphasising the need for clinical trials into prevention and management approaches so that evidence informed recommendations and guidelines can be developed.

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Consent for publication

All authors have approved the manuscript for submission. The content of this manuscript has not been published, or submitted for publication elsewhere.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

KB, JJ and JL conceived of the scoping review and participated in the design and coordination. KB & CL conducted the initial search, extracted the articles and collated the draft results. KB and CL were responsible for the coordination of the interviews drafting the manuscript. AO provided input into the background of the study and the consultation exercise. JJ and JL were responsible for editing and providing guidance on the paper and coordinating the contributions of all authors into manuscript. KB, JL and JJ were responsible for critically revising the paper. KB, CL JJ, JL and AO read and approved the final paper.

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Table 1: Description of the included studies: Saddle sores among female competitive cyclists

Category Prevalence, Prevention/Treatment	Author, year	Design, Study population, limitations	Aim, intervention	Outcome, Measures	Results , Recommendations
Prevalence + Prevention/Treatment	Weiss, 1993	<p>Design: Double blind placebo-controlled study</p> <p>Duration: One week</p> <p>Study population: 65 amateur recreational female cyclists in 1992 Grand Canyon to Mexico Bicycle Tour</p> <p>Limitation: Female and males included in study and outcomes were not reported separately.</p>	<p>Aim: Compare the efficacy of two commonly used creams with a placebo, to improve bicycle-related seat pain</p> <p>Intervention: All received 470 grams of cream to apply twice daily on the skin in contact with the saddle (buttocks, perineum, groin, scrotum).</p> <p>Treatment groups</p> <ul style="list-style-type: none"> • 0.5% hydrocortisone cream • 10% trolamine salicylate cream • Non-medicated placebo 	<p>Prevalence: self-administered questionnaire completed on last day of ride – weight, height, gender, riding experience, gel covered seat, bicycle seat height and tilt, handlebar type, shorts/pants type, previous cream use, female menstrual pads, seat pain</p> <p>Seat pain rated on 10 point scale for previous cycling, first two days of trip, end of trip and overall experience</p> <p>Prevention/Treatment: Skin cream tube was returned at the end of the ride and weighed</p>	<p>158 (84%) experienced seat symptoms</p> <p>No significant differences found between groups for rider characteristics, cycling experience and bicycle equipment variables</p> <p>The most common sites of pain/discomfort were the buttocks (40.3%) and/or the crotch/perineum (29%)</p> <p>35 cyclists (18.6%) reported using a cream in the past to prevent a problem with skin in the seat area.</p> <p>Compliance with cream use was similar in each group.</p> <p>No significant differences in degree of pain among all treatment groups</p> <p>No significant difference in skin breakdown among all treatment groups</p> <p>Two medicated creams were no more effective than placebo cream.</p> <p>Placebo group reported improvements in seat symptoms, authors hypothesise cream can be a lubrication</p>

<p>Prevalence + Prevention/Treatment</p>	<p>Baeyens et al., 2002</p>	<p>Design: Case-series Duration: Unknown Study population: 6 female competitive cyclists, 21 to 39 years old and cycle on average 462.5 km/week Limitations: Small sample; recommendations not based on study findings.</p>	<p>Aim: Describe six cases with unilateral labial swelling</p>	<p>Prevalence: Case reports Prevention/Treatment: Case reports include patient treatments, but information sources for prevention recommendations unknown</p>	<p>All cases reported history of inflammation, chafing, folliculitis and nodules related to the saddle. Five cases had scars and perineal lesions from chafing and perineal folliculitis. All cases had no family history of lymphoedema or no pelvic abnormality All cases had unilateral chronic swelling (5 cases on the right side, 1 case on the left side) All cases had optimal bicycle saddle fit, type of shorts and perineal hygiene. For surgical removal, 3 cases (aged 27, 21, 21) underwent lymphoscintigraphy, 2 cases (age 23, 38) refused, and 1 case (age 34) was not offered due to history of pelvic surgery. Authors hypothesise cause of unilateral swelling is from chronic inflammation in the vulvoperineal area and lymphatic vessel damage. Curved posture of cyclists may cause repeated compressions of inguinal lymphatic vessels Authors recommend saddle positioning, optimal type of bike shorts, good hygiene practices, elevating lower limbs, applying cold compresses, and physiotherapy for lymph drainage as prevention strategies</p>
<p>Prevalence + Treatment</p>	<p>Humphries, 2002</p>	<p>Design: Case-series Duration: Cases collected over a 12-month period Study population: 4 female competitive cyclists showing unilateral vulva hypertrophy with recurrent abrasions, infections and folliculitis. Cyclists were international and national level competitors, one was retired. Limitations: Finding speculative not based on study findings</p>	<p>Aim: Describe four cases with unilateral vulva hypertrophy</p>	<p>Prevalence/Treatment: Case reports collected by one sport science physician</p>	<p>Two cases reported pain and swelling. Locations of swelling and vulva trauma varied and included left inguinal nodes, right labium majus, left labium majus. Case 2 reported intra-vulval haematoma. Case 4 reported scar tissue and old sinus tracks near perineal skin. Case 2 identified cause of swelling and pain from long road race and poorly fitted seat. Case 1 reported oral antibiotics treatment for infection and case 2 used a local symptomatic treatment. Both cases reported vulva hypertrophy remained present. Three cases reported local infections. Case 2 had haematoma and folliculitis on both sides of groin one-year after receiving treatment. Author concludes vulval hypertrophy is more common among competitive female cyclists than general population, and the cause is unknown. Author reported repeated micro abrasions, over macro trauma may lead to infected lesion and hypertrophy. Recommended: Need to conduct prospective studies in a random sample of competitive cyclists.</p>

Prevention/Treatment	Keytel et al., 2002	<p>Design: One-arm trial</p> <p>Duration: One-week trial with three-month follow-up. Trial included 3 x 2-hour bike rides (6-hour total per person). Ride 1 used standard bicycle saddle, ride 2 and 3 used novel saddle. Cyclists used novel saddle as primary saddle for one-week</p> <p>Study population: 6 females 31 years + /- 8 years (24-46 years) 5 males</p> <p>Limitation: Female and male outcomes not reported separately. Small trial not blinded.</p>	Aim: Investigate the effects of a novel bicycle saddle on saddle-related comfort and symptoms during cycling	<p>Prevention/Treatment: Novel saddle design has a broader posterior and shorter nose, than conventional saddle design. Novel saddle is broader to support ischial tuberosities, unlike conventional saddle which supports the perineum.</p> <p>Each rider performed 3 x 2-hour stationary rides with own bicycle</p> <p>Questionnaire completed before and after trial to score saddle symptoms and saddle comfort (1 = extremely comfortable, 10 = unbearably uncomfortable) for conventional and novel saddle.</p> <p>During each 2-hour ride, saddle comfort rating and saddle symptoms were described every 15 minutes.</p> <p>3-month follow-up questions includes use of novel saddle and changes in saddle symptoms from using novel saddle</p>	<p>Pubic bone and chafing were the most common saddle-related complaint (n=4).</p> <p>Four cyclists reported severe chafing only, saddle sores, chafing and back pain, and painful pubic bones with loss of feeling in pelvic area.</p> <p>Saddle symptom scores were significantly lower among novel saddles compared with conventional saddles.</p> <p>One cyclist reported marginally worse symptoms when using novel saddle</p> <p>Saddle comfort scores were significantly lower among novel saddles than conventional saddles.</p> <p>More comfort' 'achieved immediately after first exposure to novel saddle.</p> <p>At 3 months, 9 of 11 participants still used and preferred the novel saddle. All 9 cyclists reported saddle-related symptoms decreased compared to start of trial.</p> <p>Authors conclude: novel saddle design has greater comfort, and reduced saddle symptoms compared to conventional saddle design, and can be used long-term.</p> <p>Authors recommend: health professionals to prescribe anatomically correct saddles to prevent saddle-related medical disorders and discomfort.</p>
Prevalence + Prevention	McCluggage and Smith, 2011	<p>Design: Case-series</p> <p>Duration: Unknown</p> <p>Study population: Four competitive female cyclists 15 to 45 years old.</p> <p>Case 1: 45 years Case 2: 15 years Case 3: 18 years Case 4: 19 years</p>	Aim: Describe 4 cases of female cyclists with vulva nodule or swelling	Prevalence/Prevention: Case reports from pathology archives of institutions to which the authors were affiliated.	<p>Case 1 and 4 had a nodule on the left labium majus, and case 2 and 3 had the nodule on the right.</p> <p>Size of nodule varied according to duration, from 2 cm nodule (case 1, 2 weeks) to 5 cm nodule (case 2 and 3, 12 months). Case 4 had a 6 cm nodule (duration unknown).</p> <p>Authors conclude cause of lesions were due to repeated micro trauma to the vulva from pressure and vibrations from the saddle.</p> <p>Author's state local injury can cause reparative and reactive fibroblasts and myofibroblasts to occur at the vulva, which can become more reactive if injury is sustained over time.</p>

Prevalence + Prevention	Guess et al., 2011	<p>Design: Cross-sectional Duration: N/A Study population: 48 Female competitive cyclists. Rode on average 10 miles per week, 4 weeks per month. Mean age 35.98 years (+/- 6.9 years). Recruited from previous study investigating effects of bicycle riding and female pelvic floor among cyclists and runners.</p>	<p>Aim: Investigate the relationships between saddle design, seat pressures, and genital nerve function in female competitive cyclists</p>	<p>Prevalence/prevention: Genital vibratory threshold by biothesiometry repeated 6 times Saddle pressure via map sensor by Novel Pliance pressure sensor system Cyclists rode on own bike and saddle, and data collected from 40 to 60 seconds of 20 Hz.</p>	<p>54.8% rode traditional saddles, 45.2% rode cut-out saddles.</p> <p>Authors identified three main pressure distributions for cyclists riding on traditional saddle: 1. Pressure over the bilateral ischial tuberosities 2. Pressure more widely distributed along posterior & ischial tuberosities 3. Pressure isolated to perineal region</p> <p>Authors identified 80% of women using cut out experienced highest pressure in perineal region, 20% most in bilateral ischial tuberosity</p> <p>Average perineal pressure was significantly lower among cyclists using traditional saddles compared with cut-out saddles.</p> <p>Increased saddle width associated with decreased mean saddle pressure, peak perineal pressure and total saddle pressure.</p> <p>Recommendations: Longitudinal studies of neurological assessment are necessary to provide constructive, corrective recommendations for women.</p>
Prevalence + Prevention	Hermans et al., 2016	<p>Design: Cross-sectional Duration: Not Applicable Study population: 114 female competitive cyclists from Dutch cycling association Mean age is 35.6 years (+/-9.5)</p> <p>Limitation: Low response rate (32.6%).</p>	<p>Aim: Determine the prevalence and duration of urogenital overuse injuries and sexual dysfunction in female cyclists compared to runners in the Netherlands</p>	<p>Prevalence/prevention: Questionnaire including medical history, cycling experience, cycling-related injuries (skin chafing, defects, perineal furunculosis, vulva trauma), urogenital and urological conditions during and after cycling (minimum 2-hour duration), and female sexual discomfort.</p>	<p>Skin chafing, skin defects of labia minora/majora 72 cyclists (63.2%), significantly more than runners (3%, $P < 0.01$) of which 45 reported experiencing skin chafing more than three times (39.5%).</p> <p>Overuse injury was reported at least once in 56 cyclists (50.9%), all complaints lasted at least 48 hours</p> <p>Perineal furunculosis was reported in 22 cyclists (19.3%), and 10 of the 22 cyclists (45.5%) reported experiencing perineal furunculosis more than three times.</p> <p>Vulvar oedema was reported by 40 cyclists (35.1%) and was significantly more prevalent among cyclists than runners.</p> <p>Increased saddle width had a non-significant association with vulvar discomfort.</p> <p>Increased saddle width had a significant association with presence of dysuria and stranguria.</p> <p>Older age has a significant association with higher prevalence of vulvar discomfort.</p> <p>Age and experience were not significantly associated with vulvar discomfort.</p> <p>Causative relationship for sexual dysfunction could not be determined</p>

Prevalence + Prevention	Partin et al., 2012	<p>Design: Cross-sectional Duration: Not Applicable Study population: 41 female competitive cyclists Follow up study to Guess (2011) article Limitation: Participants positioning handlebars above their saddle were excluded</p>	<p>Aim: Assess the effects of bicycle setup and cyclist's attributes on genital sensation and saddle pressures among female cyclists</p>	<p>Prevalence: Questionnaire Prevention: Questionnaire assessing handlebar at two heights: level with saddle and lower than saddle. Genital sensations and saddle pressure assessed by biothesiometry and map sensor.</p>	<p>62% reported a history of genital numbness, tingling or pain in the last month</p> <p>Lower handlebars significantly increased saddle pressure.</p> <p>Saddle with lower handlebars had significantly higher saddle pressure in the mean perineum than handlebars at seat level.</p> <p>Saddle with lower handlebars had significantly lower anterior vaginal sensation than handlebars at seat level.</p> <p>Authors state lower handlebars may cause riders to lean forward and shift more weight to the perineal region instead of leaning back onto ischial tuberosities.</p>
Prevalence + Prevention/Treatment	Countant-Foulc, et al., 2014	<p>Design: Case-series Duration: Unknown Study population: Female competitive cyclists (n=8) Mean age: 45 years (18-68 years) Cycling range 125-40 km, median 245 km per week)</p> <p>Limitations: Recommendations not based on findings.</p>	<p>Aim: Assess clinical features, imaging results, histopathologic patterns, clinical outcomes from vulval swelling as a result of intensive cycling</p>	<p>Prevalence/Prevention/Treatment : Cases information obtained from 3 French and 1 British vulval specialists from European College for the Study of Vulval Disease. One case was obtained from a sports medicine physician</p> <p>Imaging, histopathological examinations, management and treatments were described.</p>	<p>All had unilateral swelling of labium majus, mean swelling duration was 6.1 years. Three cases reported folliculitis, 2 cases reported hair loss and one case reported swelling of the clitoral hood.</p> <p>Five cases had an MRI examination, of which 2 cases had vulva asymmetry and 3 cases had labium enlargement. Case 8 had reported an 18 mm nonvascular cyst posterior to the left labia.</p> <p>Six cases had surgical excision, of which 4 cases resumed cycling without problems up to 5 years follow-up. Five cases were satisfied by the cosmetic procedure.</p> <p>Case 4 had swelling occur 20 months post-surgery with postoperative hematoma, and case 8 stopped cycling. Two cases required a second surgery to improve cosmetic appearance. Case 3 was offered surgery but declined and still has swelling and folliculitis present.</p> <p>Case 7 manages swelling by using padded shorts and using non-nose saddle but swelling remains. After surgery, case 1 used as a softer and wider saddle with no recurrence after 66 months.</p> <p>Authors hypothesise prevention measures should target reducing friction. Padded shorts, using a wider saddle without an anterior nose, moving the saddle slighting forward and tilting the saddle down, correct position of hands and feet may help.</p> <p>Authors recommend using cold packs on the vulva, leg elevation post-cycling, reducing time of cycling and prompt treatment of perineal wounds to prevent vulval swelling.</p>

Prevalence + Prevention	Gaither et al., 2018	<p>Design: Cross-sectional Duration: Not Applicable Study population: 409 High intensity female cyclists, 1656 low intensity cyclists and non-cyclists from 5 sporting clubs in US, Canada, UK, Australia and NZ</p> <p>Runner and swimmers were comparison group n=1053</p> <p>Limitation: Low response rate (53.3%)</p>	Aim: Explore the relationship between cycling and sexual and urinary dysfunction	Prevalence/Prevention: Questionnaires including the Female Sexual Function Index, American Urological Association Symptom Index, questions about the history of urinary tract infections (UTIs), genital numbness, and genital saddle sores	<p>Authors analysed prevalence of saddle sores and genital numbness among all female cyclists.</p> <p>814 female cyclists have experienced genital numbness.</p> <p>797 of all female cyclists have experience saddle sores. Of those which have experienced saddle sores, its location included labia/vagina (n=53), thighs (n=22), buttocks (n=16), perineum (n=9) and other (n=14).</p> <p>Low and high intensity cyclists had greater odds of reporting saddle sores and genital numbness than non-cyclists.</p> <p>Low and high intensity cyclists had greater odds of reporting saddle sores and perineal numbness than non-cyclists, after adjusting for age, body mass index, hypertension, diabetes, ischemic heart disease, tobacco use, urinary symptoms, race, and marital status</p> <p>No difference in odds of reporting saddle sores by saddle type. Authors hypothesised cyclists who develop saddle sores change saddle type.</p> <p>Higher handlebars higher or same saddle height or standing was associated with reduced odds of saddle sores.</p> <p>Cyclists reported they never wore padded shorts had lower odds of genital numbness and saddle sores.</p> <p>Off-road cycling had significantly higher odds of saddle sores than those riding in urban streets.</p> <p>Authors' hypothesised changes in seat pressure is more extreme in off-road conditions.</p>
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