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The Relationship Between Bicycle Saddles and The Incidence of Erectile Dysfunction In Men : A Systematic Review

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Objectives. There is conflicting evidence about the relationship between bicycle saddle type and erectile dysfunction (ED). The main limitation of some previous studies is the lack of a validated measure of ED.
Methods. We searched several databases from an English-language medical literature review that was made of publications in peer review journals, including published abstract presentations at major medical meetings, using a variety of search terms relating to “bicycle saddle” and “erectile dysfunction”.
Results. After systematic evaluation of 359 studies, 7 studies met our inclusion criteria. In general, cycling significantly reduced perineal oxygen pressure levels ($p<0.05$). When comparing between studies, cycling more than 3 hours per week was an independent relative risk (RR=1.72) of moderate to severe ED. In a narrower saddle, when examining perineal oxygen pressure, there was a decrease, where it was found that $p<0.001$, where significantly a narrower saddle increased compression at the perineal saddle interface which disrupted penile hemodynamics.
Conclusions. Limited evidence supports a positive correlation between narrower bicycle saddles and compression of the perineal arteries which causes occlusion of penile perfusion, penile blood flow and can lead to endothelial damage and causes erectile dysfunction. Long bike rides with seated positions might cause temporary penile blood flow reduction due to perineal artery pressure, resulting in decreased erectile function. However, this issue usually resolves quickly when pressure is relieved. Heterogeneity between studies suggests the need for further investigation of specific saddle types for cyclists and the measurement.

Keywords: bicycle, bicycle saddle, erectile dysfunction

Introduction

Recently, riding a bicycle is a recreation and sport that has become increasingly popular among the general public Cycling's popularity has surged post-COVID-19, with lockdowns and social distancing measures. It's not just a recreational activity but also an eco-friendly mode of transport [1-2]. Cycling benefits cardiorespiratory and cardiovascular fitness but carries health risks like traumatic injury and concerns about genitourinary health due to saddle seat shape [3-4].

The relationship between bicycle saddles and the incidence of erectile dysfunction (ED) in men has been a topic of interest among researchers and cyclists alike. Riding a bicycle for prolonged periods, especially on saddles that are poorly designed or improperly adjusted, can potentially compress the perineal area (the region between the anus and the scrotum), leading to reduced blood flow to the penis and nerves, which may contribute to ED. Previous research has shown a link between cycling and erectile dysfunction (ED). However, there is limited discussion about the specific role of bicycle saddles in this condition. ED can be caused by pressure on the penile artery, which can be influenced by the type of saddle used. Past studies have reported consistent results regarding the association between cycling and ED but not too much has been discussed about the types of saddles used for erectile dysfunction. There are limitations, including the absence of a control group, small sample sizes, and lack of validated measures for ED and penile blood flow. Thus, further research is needed to explore the impact of different saddle types on ED [5-6].

The aim of this literature is to review existing literature using systematic review research criteria to assess the relationship between bicycle saddle type and the incidence of erectile dysfunction in cyclists.

Materials and Methods

Search Strategy and Study Selection

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Fig. 1) guidelines were used for conducting the systematic review. PubMed, EMBASE, CINAHL via EBSCO, Web of Science, and the Cochrane Database were among the databases that were searched. Only articles with the medical subject heading "bicycle peddals" or the terms "bicycl-," "cyclist," "cycling," "peddal," or "bicycle ped-" in the title or abstract were eligible for the search strategy. Additionally, articles had to contain the medical subject heading "erectile dysfunction," or "erectile," in the title or abstract, or the terms "sexual function," "sexual dysfunction," "sexual health," "erectile function," or "erectile dysfunction" in the text.

Studies that employed a validated measure of perineal blood pressure in ED, were written in English, presented original data, and compared ED between cyclists and non-cycling controls were considered. An instrument has to have satisfied specified standards for construct validity, test-retest reliability, and internal consistency in patients with ED in order to be deemed validated. For screening, both published and unpublished data were used. Excluded studies included case reports, lacked a control group, used a clinically validated ED measure, had an outcome measure other than ED, were not written in English, and did not report original data (i.e., reviews, duplicate data, or publications).

The imports of references from the literature search were screened using the Covidence systematic review software. The full text review came after the authors had reviewed the publications' titles and abstracts. At every level, inclusion and exclusion criteria were used. A full text review was conducted for the studies that the title and abstract information did not allow to be eliminated. Only the manuscript was included when it was determined that there was an abstract and a separately published manuscript utilizing the same data set.

Data Extraction

The following information was taken from each study: perineal oxygen tension, age, test results, and, if available, a description of the intensity of the cycling. for research where the subset that was employed is not specified, where there is missing data, or where the cycling intensity is not clear. For both bikers and non-cyclists, ED—defined as the existence of variations in perineal oxygen pressure—was the main result.

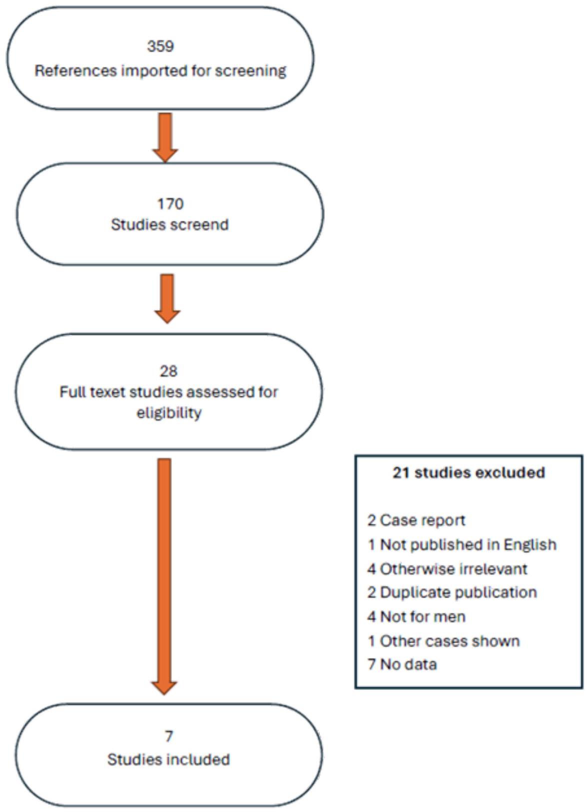

Figure 1. PRISMA flow chart showing study selection. PRISMA ¼ Preferred Reporting Items for Systematic Reviews.

Quality Assessment

Study quality assessed independently and discrepancies resolved by author.

Data Analysis

In order to offer a theoretical explanation for its pathophysiology and the underlying cause of the correlation between two variables, mechanistic investigations are crucial. It is hypothesized that the straddle bicycle saddle, which has an increased perineal compression pressure perineum-saddle contact, is the cause of ED in cyclists. It has been observed that the measurement exceeds the systolic perfusion pressure, which momentarily blocks blood flow to the penis. There is a theory that suggests that high compressive stresses at the perineal-saddle interface during conventional riding may cause endothelial damage in the penile artery in certain cyclists. Seats may lead to ED.

Results

A systematic evaluation of 359 studies resulted in 7 studies meeting the inclusion criteria, as shown in Figure 1. Of these, 6 studies included published data and 1 included published abstracts. The studies focused on populations with different bicycle saddle types and descriptions. Majority of the research used a one-group posttest design, while Table 1 presents the recruitment methodology and activity level of the subjects.

In a 2005 study conducted by Cohen, a group of male cyclists between the ages of 20 and 50 were examined. These cyclists averaged more than 80 miles of road bicycling per week for two months prior to the study. Participants had no history of vascular disease, diabetes, or sexual dysfunction, and had recently had an erection. The results of the study revealed that the seated cycling test-retest reliability for tpO2 values had an ICC (3,1) of 0.76 and a mean absolute difference of 5.1 mmHg.

Table 1. Activity characteristics of study subjects

Study	Type	Group	Recruitment Source	Activity Description
JD Cohen, 2005 [7]	Abstract	Cyclist	31 male cyclists, ages 20-50, cycled >80 miles/week for 2 months.	Test-retest reliability: seated cycling tpO2 (ICC 0.76, difference 5.1 mmHg), standing cycling tpO2 (ICC 0.88, difference 7.23 mmHg). Seat design had no effect on tpO2 values. Seated cycling significantly reduced tpO2 levels compared to standing cycling (P<0.05). Percent decreases in tpO2: Vetta 76%, Terry 73%, Specialized 62%.
Vincent Huang, 2005 [8]	Manuscript	NA	21 publication from 1999 to 2004 investigating the relationship between bicycle riding and erectile dysfunction (ED).	Bicycle riding for more than 3 hours per week was found to have a relative risk of 1.72 for moderate to severe erectile dysfunction (ED).
Ulrich Schwarzer, 2002 [9]	Manuscript	Cyclist	20 healthy young men without erectile dysfunction tested 4 different bike saddle designs during seated cycling.	Cycling led to decreased penile oxygen pressure due to perineal compression, with unexpected differences in the levels observed: (A) mean PtcO2 11.8 mmHg, decrease in initial oxygen pressure 82.4%; (B) mean PtcO2 20.8 mmHg, decrease in initial oxygen pressure 72.4%; (C) mean PtcO2 25.3 mmHg, decrease in initial oxygen pressure 63.6%; (D) mean PtcO2 62.3 mmHg, decrease in initial oxygen pressure 20.3%.
James J Potter, 2008 [10]	Manuscript	Cyclist	11 males cyclist 11 females cyclist	Male centers of pressure were farther forward in the anterior and total saddle regions than they were for females. Females exhibited a larger IT width than males.
Ricardo Munarriz, 2005 [11]	Manuscript	NA	Any subjects who cycle in a stationary bicycle	The left/right CAPSV values were lower on A and B compared to sitting on A and B. Perineal compression pressures were higher on A and B compared to sitting upright on an examination table.
S-J Jeong, 2002 [12]	Manuscript	NA	20 male volunteers	Penile blood flow decreased significantly before cycling and varied on different saddles after cycling.
G Breda, 2005 [13]	Manuscript	cyclist	**29 healthy voluntary cyclist**	Statistically significant t-test showed SMP saddle's superiority in preventing vascular compression.

Meanwhile, the test-retest reliability for standing cycling tpO2 values had an ICC (3,1) of 0.88 and a mean absolute difference of 7.23 mmHg. Seat design did not significantly affect tpO2 values, but seated cycling did lead to lower tpO2 levels compared to standing cycling. The seats tested did not show any significant ability to protect penile tp levels, and further investigation is needed to understand the impact of cycling on penile physiology.

A study by Vincent Huang in 2005 investigated the link between bicycle riding and erectile dysfunction (ED). They found 21 publications between 1999 and 2004 on this topic. It was discovered that riding a bicycle for more than 3 hours per week increased the risk of moderate to severe ED (relative risk = 1.72). In comparison to runners and swimmers of the same age, bicyclists had a higher prevalence of moderate to severe ED (4.2% and 4% vs. 1.1% and 2% respectively, p≤0.018 and p=0.05). To reduce the risk of ED, bicyclists should consider changing their saddle to a noseless seat, adopting a more upright or reclining position, using a gel saddle, and tilting the saddle downwards. The study suggests that the interaction between the rider and the bicycle saddle at the perineum-saddle interface is responsible for the mechanism behind this association. Hypothetically, saddles with a nose extension can lead to high pressure on the perineum, temporarily blocking blood flow to the penis, and potentially causing endothelial injury and vasculogenic ED.

Ulrich Schwarzer (2002) investigated the effects of different bike saddle designs on 20 healthy athletic young men without a history of erectile dysfunction. Four saddles were used: (A) narrow heavily padded seat; (B) narrow seat with medium padding and a V-shaped groove in the saddle nose ("body geometry"); (C) wide unpadded leather seat; (D) women's special wide seat with medium padding and no saddle nose. During cycling in all seats a decrease in penile oxygen pressure could be observed, reflecting perineal compression. But the differences were unexpected: (A) mean PtcO2 11.8 mmHg, decrease in initial oxygen pressure 82.4%; (B) mean PtcO2 20.8 mmHg, decrease in initial oxygen pressure 72.4%; (C) mean PtcO2 25.3 mmHg, decrease in initial oxygen pressure 63.6%; (D) mean PtcO2 62.3 mmHg, decrease in initial oxygen pressure 20.3%. Surprisingly, seat (D) had the highest initial oxygen pressure and the smallest decrease, while seat (A) had the lowest initial pressure and the largest decrease. The study showed that cycling in a seated position leads to decreased penile blood flow due to perineal artery compression.

James J. Potter's study on 11 male and female cyclists revealed that males have a more forward center of pressure in the anterior and total saddle regions compared to females. Additionally, females exhibit a larger IT width than males. These gender-related differences in saddle loading should be considered when designing saddles.

Ricardo Munnariz conducted a study in 2005 involving subjects who cycled on a stationary bicycle. The values of right/left CAPSV (cm/second) on saddles A and B were significantly lower than when sitting on saddles A and B. Right/left CAPSV (cm/second) values straddling A(ns) and saddle B(ns) (0.7 +/- 2.9/1.5 +/- 6.2 and 0/0, respectively) were significantly lower than values obtained while sitting on A(ntcs) and B(ntcs) (25.6 +/- 13.4/23.8 +/- 12.0 and 17.3 +/- 6.4/18.3 +/- 6.5, respectively) (P < 0.001). Mean perineal compression pressures (mm Hg) on A(ns) and saddle B(ns) (315.2 +/- 39 and 387.9 +/- 64.3, respectively) were significantly higher than values obtained while sitting upright on an examination table (47.6 +/- 5.2 and 46.0 +/- 8.1, respectively) (P < 0.001). Additionally, the mean perineal compression pressures on saddles A and B were significantly higher compared to sitting upright on an examination table. This indicates that sitting on certain bicycle saddles generates enough compressive forces at the perineal-saddle interface to obstruct arterial inflow, leading to diminished penile hemodynamics.

In a 2002 study by S-j Jeong, 20 healthy men were tested using a Doppler flowmeter. They were measured in both standing and sitting positions on a narrow and wide saddle before and after cycling for 5 minutes. Before cycling, penile blood flow decreased significantly on both saddle types. Before cycling, penile blood flow (ml/min/100 g tissue) was significantly decreased from 1.6+/-0.7 to 1.5+/-0.7 (P=0.010) on the wide saddle and from 1.7+/-0.6 to 1.0+/-0.5 (P<0.001) on the narrow saddle. After cycling, penile blood flow changes were greater on the narrow saddle compared to the wide saddle. After 5 min of cycling, the changes in penile blood flow on the wide and narrow saddles were 0.34+/-0.49 and -0.38+/-0.49, respectively (P<0.001). This suggests that the narrow saddle may cause more significant reductions in penile blood flow, potentially leading to erectile dysfunction.

A 2005 study conducted with 29 healthy voluntary cyclists found that the SMP saddle showed clear superiority in preventing vascular compression on the perineal structures. The experiment confirmed the effectiveness of the SMP saddle in limiting compression on the pelvic floor and its compatibility with the seat dimensions preferred by cyclists for long distances.

Discussion

Limited evidence supports a positive correlation between narrower bicycle saddles and compression of the perineal arteries which causes occlusion of penile perfusion, penile blood flow and can lead to endothelial damage and causes erectile dysfunction. Long bike rides with seated positions might cause temporary penile blood flow reduction due to perineal artery pressure, resulting in decreased erectile function.

The cause of erectile dysfunction (ED) from bicycle riding is not fully understood, but it is believed to be due to continuous compression and strain on the pudendal nerve and arteries, resulting in nerve entrapment and vascular occlusion. The pudendal nerve carries motor and sensory fibers and is responsible for transmitting somatosensory signals from the genitalia. It also controls the perineal muscles necessary for a rigid penile erection. The pudendal nerve passes through the pudendal canal and innervates the perineum and genitalia. The internal pudendal arteries, which supply blood to the genital area, run alongside the pudendal nerve. During cycling, the downward force and pressure on the perineal region can pinch and compress the pudendal nerve against the pubic bone. The pedaling motions and impacts experienced while cycling on a narrow saddle can further contribute to nerve compression in the pudendal canal. Additionally, pedaling in a forward inclined position can stretch the pudendal nerves, leading to strain. The pathogenesis of pudendal nerve compression syndrome is likely due to hypoxemia of the nerve or a primary neuropathic process caused by mechanical pressure. Low-magnitude extraneural compression decreases intraneural microvascular blood flow, impairs axonal transport, and alters nerve structure and function within minutes or hours. The duration and amount of pressure determine the severity of neural damage. Erectile impairment in cyclists may be caused by insufficiency of penile blood supply due to perineal arterial compression. Arterial insufficiency can up-regulate TGF-b1 expression, inducing collagen and connective tissue synthesis in the corpus cavernosum and inhibiting growth of vascular smooth muscle cells. Prostaglandin E (PGE) activation during high oxygen tension suppresses TGF-b1-induced collagen synthesis and induces smooth muscle relaxation. Penile compliance and erectile function rely on the dynamic interaction between TGF-b1 and PGE. Hypoxemia from insufficient penile blood supply hinders achieving an erection, leading to erectile dysfunction [14].

The impact of saddle design on blood flow during cycling in a seated position is significant. Sommer et al. conducted a study on male cyclists aged 20-37 years to evaluate the effects of seat position, saddle size, and saddle geometry on penile oxygenation. Cycling in a 90-degree position resulted in 40% better penile oxygenation than cycling in a 60-degree position, regardless of the saddle type. Wider saddles also showed over 50% better penile oxygenation compared to narrow saddles. The presence or absence of a hole in the saddle did not significantly affect penile oxygenation. Schwarzer and colleagues investigated the influence of saddle designs on penile perfusion in 20 healthy young men. Results showed that saddle width and the absence of a nose had a significant impact on penile oxygenation. The narrow heavily padded seat elicited the lowest initial oxygen pressure, while the women's special wide seat with medium padding and no nose provided the best penile oxygenation. Using a Doppler flowmeter, another study showed that cycling on a narrow saddle resulted in a greater decrease in penile blood flow compared to a wide saddle. This emphasizes the importance of saddle shape on penile blood flow. However, reduced penile blood flow or oxygen pressure does not necessarily lead to erectile dysfunction. Rodano et al. compared traditional saddles with flat surfaces to saddles with a hole in the perineal region. The saddle with a hole transferred greater pressure to the perineal vessels and nerves, causing pain and discomfort for cyclists. The nose of the saddle was assessed by Lowe et al., revealing that traditional sport/racing saddles with a protruding nose had more pressure in the perineal region compared to saddles without a nose. Lastly, Goldstein and colleagues investigated the impact of narrow saddles with nose extensions and noseless saddles on penile hemodynamics and perineal compression forces. Results showed that slim saddles with nose extensions significantly reduced cavernosal peak systolic velocity, while two-cheek noseless seats had minimal reduction in peak systolic velocity and increased perineal pressures. Overall, saddle design plays a crucial role in blood flow and oxygenation during cycling, particularly in the perineal region. Saddle width, the presence or absence of a nose, and saddle shape are important factors to consider in preventing compression of the perineal arteries and ensuring optimal penile oxygenation and blood flow [14][15-16].

A history of perineal trauma is a significant risk factor for vasculogenic erectile dysfunction (ED), but its characterization among the studies in the analysis was inconsistent. Falls onto the top tube of a bicycle frame commonly cause perineal trauma in cyclists. Blunt perineal trauma, including bicycle accidents, can lead to arterial occlusive disease and subsequent impotence. The compression of the perineum during cycling may cause ED through endothelial injury, arterial insufficiency, chronic hypoxemia, and corporal fibrosis. However, the extent to which chronic perineal compression causes changes comparable to traumatic injury remains unclear. The cardiovascular benefits of cycling may improve erectile function in certain populations, but the risks of trauma and perineal compression may offset these benefits [15].

A 2009 report from NIOSH suggests that using a "no-nose" saddle can prevent genital numbness and sexual dysfunction in occupational bicyclists. Non-traditional bicycle saddle designs that do not have a narrow protruding nose or have a large hole and a shape that properly supports the ischial tuberosities have been shown to reduce pressure in the perineal region and decrease the risk of erectile problems. Saddles with a narrow cutout, on the other hand, can increase pressure on the pudendal vessels and nerves. The pressure on the perineum is inversely related to surface area, so a saddle without a cutout may offer more protection against erectile dysfunction compared to a saddle with a narrow hole and hard edges. However, saddles with a wide cutout, which do not compress the nerves and vessels in the perineal region, have shown significantly better results. These findings suggest that a saddle with a wide hole and no edges, and the proper width to support the ischial tuberosities, provides the most effective protection. It's important to note that using a no-nose seat may affect steering performance and rider confidence, potentially leading to higher rates of perineal injuries. The impact of changing a bicycle seat on erectile function is not clear, but a study involving 121 bicycling police officers found that after using no-nose saddles for 6 months, participants reported significantly less numbness and improvements in erectile function and tactile sensitivity. However, further research is needed to determine if the 6-month time span was sufficient to observe significant improvements in nocturnal erections and if the changes in erectile function from cycling are permanent [14][17-18].

The type of saddle padding material may influence the risk of bicycle-induced erectile dysfunction (ED). Riding on a hard non padded saddle has been associated with better penile oxygenation compared to a gel saddle. Additionally, the absence of padding minimally compresses the perineal vessels. The optimal saddle appears to be wide, unpadded, and no-nose, allowing proper placement of the sit bones. A more horizontal or downward-pointing saddle position reduces pressure on the perineum. Tilting the saddle downward by 10 degrees reduces perineal stress by 44%. However, this position may increase pressure on the hands and cause instability on the seat. A horizontal saddle position is ideal. Proper bicycle fit, adjustment of saddle height and angle, and positioning of handlebars can reduce the risk of ED. Riding in a more upright position results in greater penile blood flow compared to a 60-degree position. Professional cyclists have better blood flow in a 30-degree position. Switching body positions every 10 minutes from seated to standing is recommended for recreational cyclists to promote blood flow to the penis [14][15][17].

The study has limitations including the type of research design most used in the study one group posttest design. One of the main limitations of a one-group posttest design is the lack of a control group or comparison condition. Without a control group, it can be challenging to determine whether any observed changes in the outcome variable are solely due to the intervention or if other factors could have influenced the results. Despite its limitations, a one-group posttest design can still provide valuable insights into the effects of interventions or treatments, especially in situations where it may be impractical or unethical to include a control group. However, researchers should interpret the results with caution and consider alternative research designs whenever possible to strengthen the validity of their findings. Some studies failed to mention the ED standards, making it difficult to understand the lack of differences in ED criteria. Publication bias was not assessed due to limited studies meeting inclusion criteria, but both published and unpublished studies were considered. A single study on intense cycling on rough terrain reported an increased risk for erectile dysfunction (ED) but didn't consider factors like cycling intensity, equipment, and terrain due to variations in reporting among studies. The study did, however, have strengths like using validated outcome measures for ED, addressing age and comorbidities, and highlighting the need for more controlled prospective studies to determine causation and duration of the effect of cycling on ED. Further research is required in this field. Heterogeneity between studies suggests the need for further investigation of specific saddle types for cyclists and the measurement.

Conclusion

Limited evidence suggests that a positive correlation exists between narrow bicycle saddles and compression of the perineal arteries, which can lead to erectile dysfunction. Long bike rides in seated positions can cause temporary reduction in penile blood flow due to perineal artery pressure. The cause of erectile dysfunction from bicycle riding is believed to be continuous compression and strain on the pudendal nerve and arteries, resulting in nerve entrapment and vascular occlusion. Saddle design plays a crucial role in blood flow and oxygenation during cycling, with wider saddles and those without a nose showing better penile oxygenation. Chronic perineal compression and trauma can also lead to erectile dysfunction. Using a "no-nose" saddle can help prevent genital numbness and sexual dysfunction in cyclists. The type of saddle padding material may also influence the risk of erectile dysfunction, with unpadded and no-nose saddles being more beneficial. Proper bicycle fit and positioning can reduce the risk of erectile dysfunction. It's important to note that the study has limitations, including the lack of a control group and variations in reporting among studies. Further research is needed to determine the causation and duration of the effect of cycling on erectile dysfunction.

Conflict of Interest

The authors declare that they have no conflict of interests.

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