Lower back pain in cyclists: A review of epidemiology, pathomechanics and risk factors

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Abstract

Lower back pain (LBP) appears to be a common overuse injury in cycling. However, there are few scientific studies that report on the epidemiology and risk factors associated with LBP in cyclists. The prolonged flexed posture that a cyclist maintains may lead to increased mechanical strain of the lumbar spine, causing LBP. In this article, the epidemiology, pathomechanics and risk factors associated with LBP in cyclists will be critically reviewed.

An extensive literature review was conducted using an evidence-based approach. Using selective keywords (lower back pain, cyclists, bicycle set-up, risk factors) a search was undertaken on the PubMed database to identify all research publications that relate to lower back pain in cyclists.

Although epidemiological studies were limited, LBP was shown to be a common cycling overuse injury. The point prevalence of LBP in cyclists ranged from 10-60%. It has been suggested that LBP in cyclists may be prevented by adjusting certain bicycle parameters to match the anthropometric measurements of the cyclist. Pathomechanical hypotheses for the development of LBP in cyclists are poorly supported, and most studies were conducted over time periods shorter than one hour. Monitoring cyclists over a longer period of cycling may yield more accurate data. There is strong evidence supporting the incorrect saddle angle as an intrinsic risk factor is associated with LBP in cyclists.

In conclusion, additional research on the epidemiology of LBP in cyclists is necessary. Further research studies, such as case control and intervention studies are necessary to study pathomechanics and risk factors associated with LBP in cyclists. Keywords: lower back pain, cyclists, risk factors, bicycle set-up
Introduction

Cycling is generally regarded as a sport with great potential for fitness and rehabilitation\(^1\). Additionally, cycling has the added value of not being associated with repetitive joint impact\(^2-4\). Despite this advantage, it has been shown that there is still a risk for the development of acute, traumatic injuries, as well as overuse injuries in cycling\(^5-11\).

There are only a few studies that document the incidence, and even fewer, the prevalence of overuse injuries in cyclists. In addition, it is difficult to draw comparisons between the limited number of studies of overuse injuries, as population samples and the time periods over which studies were conducted (exposure), vary between studies \(^3;12-14\). There are no known studies that report the lifetime prevalence of LBP in cyclists.

In addition to the limited research on the epidemiology of LBP in cyclists, there are also very few studies to determine the aetiology of LBP in cyclists. The aim of the cyclist is to produce maximal power at the pedals to propel the bicycle forward\(^1\). To maximise speed the cyclist must reduce aero-dynamic drag. This is achieved by maintaining a position of flexion of the hips and spine. This prolonged flexed posture may be an important factor contributing to the development of lower back pain in cyclists as posterior active and passive spinal structures may be subjected to increased load and strain in this position\(^3;7;15;16\).

Therefore to optimise the cyclist’s position and limit strain and injury to the lower back, while maintaining efficient power output, specific attention must be paid to the correct bicycle “set-up”. The bicycle “set-up” refers to the various adjustable parameters on the bicycle, including, amongst others, reach distance from seat to handle bars and saddle angle. These parameters must be adjusted relative to the cyclist’s unique anthropometric measurements to ensure correct positioning of the cyclist on the bicycle\(^1;6;17\). Although various researchers and authors have documented advice for the “optimal” bicycle set-up, much of the advice appears to be anecdotal or concentrates on performance (power output) rather than on injury prevention and the comfort of the cyclist\(^1;6;18-21\).

Lower back pain may be defined as pain in the lower back or lumbar region, and it may be intermittent or constant. For the purpose of this article the discussion of LBP will be confined to spondylogenic LBP, which is defined as pain originating from the spine and its associated structures.

A review of what is currently known about the epidemiology of LBP in cycling will follow. The bicycle set-up and related biomechanics will then be briefly discussed. Proposed hypotheses on the pathomechanics of LBP in cyclists and risk factors associated with LBP in cyclists will also be reviewed.

Epidemiology of lower back pain in cyclists

The epidemiology of LBP in cyclists in this review is defined by the prevalence and incidence of this overuse injury. Prevalence can be defined as the “overall proportion of a population who suffer from an injury”\(^22\). Two
types of prevalence are examined. Point prevalence describes cyclists who experience LBP at a particular point in time, and lifetime prevalence refers to cyclists who have experienced cycling related LBP at some point in their entire cycling career. The incidence of LBP is always linked to exposure over a particular time period.

It appears that LBP is more common in some athletes than in others. In a prospective study it was found that wrestlers had the highest point prevalence of severe low-back pain (54%), while rates were lower for tennis (32%), and soccer players (37%) respectively23. In another study, wrestlers were again found to have a higher lifetime prevalence of lower back pain (59%) compared with 23% in heavyweight lifters24. Competitive male and female rowers had a 15% and 25% point prevalence of lower back pain respectively25. In one study, with a small sample size, a high incidence of LBP was reported in elite rhythmic gymnasts (six out of seven), over a seven-week period26. Therefore the prevalence and incidence of LBP varies in different sports, while interpretations of the data are difficult as the same methodology and definitions for LBP have not been consistently applied in all studies.

The focus of this review is on cycling, but there are no known published data on the lifetime prevalence of lower back pain in cyclists. A number of surveys have investigated overuse injuries among recreational cyclists and elite cyclists3,13,14. The incidence of LBP in two separate staged multi-day cycling events varied from 2.7 - 15%. The details of these studies indicate that: (1) only 2.7% of the participants (n=113) in a bicycle tour (805km over 8 days) reported significant LBP3, and (2) 15% of the participants (n= 89) in a long distance cycle tour (4500 7242km over 80 days) experienced LBP13. Point prevalence statistics of LBP in cycling ranged from 10 - 60% and details of the studies indicate that: (1) 10% of cyclists (n=20) who responded to a research questionnaire suffered from LBP (it is not clear what the actual prevalence of LBP was in the larger group of which the 20 respondents were a subset27), (2) 30% of cyclists (n=518) who responded to a mailed questionnaire experienced LBP14, (3) and 60% of cyclists reported suffering from LBP in a squad medical questionnaire of 424 elite cyclists. This made LBP the most common injury that the riders encountered.

It is clear that there are limited studies on the epidemiology of LBP. Furthermore, the methodology employed by researchers in studies that have been conducted varies considerably, and this makes interpretation of the data difficult. The position of the cyclist on the bicycle relative to the development of LBP will now be discussed.

Cyclist’s position and bicycle set-up

An important consideration is that although an “optimal” posture may be adopted by the cyclist, cycling still places the upper body in an unnatural position.

In the seated position during cycling the optimal position is one of hip flexion, anterior pelvic tilt and a reduced spinal flexion. This position would minimise wind resistance1;15;27;28 and this could improve cycling speed27, and may also reduce the risk of spinal injury. However, very few cyclists, often only elite cyclists, maintain this ideal position. Most cyclists maintain a position in which there is a varying degree of spinal flexion, as well as varying angles of anterior and posterior pelvic tilt29,30.

The key bicycle set-up parameters which most affect the upper body position of the cyclist will be discussed, namely, reach and saddle angle. These will be discussed separately.

Reach distance

The reach distance is defined as the measurement from the centre of the seat tube/post to the transverse position of the middle of the handle bars1;17. It has been suggested that LBP in cyclists may be related to an incorrect reach distance6;7;20. However, opinions differ regarding the correct reach distance from the saddle to the handle bars. One opinion is that, in order to prevent back pain in cycling, the reach should be decreased so that the cyclist can adopt a posterior pelvic tilt position1;7;12;18. A directly opposing opinion is that most often the cyclist experiences problems in the lower back due to insufficient reach, and that the reach distance should in fact be increased20.

The explanation that motivates the suggestion that reach distance should be longer rather than shorter is based on anatomical principles20. However, further research would
be required for adequate validation of this explanation. These researchers suggest that if the reach is too short the lumbar spine is placed in a position of increased flexion, and the cervical spine may often assume an increased lordotic position relative to the thoracic kyphosis. This exaggerated unnatural position of the spine may lead to neck and back pain. A shortened reach distance and the resultant increase in lumbar flexion may result in a posterior tilt of the pelvis. This position of the pelvis, coupled with excessive flexion of the lumbar spine, may place increased mechanical strain on the posterior spinal structures. By increasing the reach distance and allowing the pelvis to adopt an anterior pelvic tilt, the cyclist can maintain a more neutral position of the vertebral column, thereby creating a more stable posture closer to the rear of the saddle. The reach distance may be altered by adjusting the stem length, saddle set-back and handle bar height.

**Saddle angle**

The saddle angle is an important factor that can influence the position of the pelvis. An increased anterior pelvic tilt and a resultant decreased tensile stress to the longitudinal ligaments of the lumbar spine have been reported with a downward tilting saddle. The discussion of the bicycle set-up provides background for the discussion of the different hypotheses for the development of lower back pain in cyclists.

**Pathomechanics of lower back pain in cyclists**

There are limited research data to determine the possible pathomechanical mechanisms responsible for the development of LBP in cyclists. Furthermore, existing research is often limited by sub-optimal study designs and sample sizes. In this section, the data in support of the different hypotheses for the pathomechanics of LBP in cyclists will be reviewed.

It has been documented by various researchers that there is an association between LBP and frequent forward bending and prolonged sitting with the lumbar spine in a flexed position. Spinal flexion is also associated with increased discal pressures. These mechanisms for the development of LBP could possibly be applied to cyclists who spend extended periods in a flexed position. However, the main difference in cycling is that a portion of the cyclist’s mass is supported on the handlebars, unlike the open chain positions that are encountered in occupational and other settings. Furthermore, cyclists are not stationary, and the lumbar spine also has to absorb intersegmental joint reaction forces and moments that are generated by the lower limbs during pedalling. These forces and moments are transferred through the thoracolumbar spine while the trunk is in a flexed and sometimes rotated position.

A number of hypotheses to explain the pathomechanics of cycling related lower back pain have been suggested. These hypotheses can be classified as: 1) the flexion relaxation hypothesis, 2) the muscle fatigue hypothesis, 3) over-activation of the spinal extensors hypothesis, 4) the mechanical creep hypothesis and 5) the disc ischaemic hypothesis. These hypotheses for the development of LBP in cyclists will now be reviewed.

**The flexion-relaxation hypothesis**

The flexion-relaxation (FR) hypothesis for the development of LBP in cyclists suggests that a deactivation of the erector spinae and/or the multifidus muscles occurs as the spine maintains a flexed position during cycling. As muscles relax, load is then shifted to the passive structures, such as the ligaments, and possibly the deeper muscles. A review of studies to identify if the FR response occurred in the seated cycling position revealed only one study in which FR of the erector spinae occurred in the flexed racing position. However, this study was limited by a small sample size.

**Muscle fatigue hypothesis**

The muscle fatigue hypothesis suggests that the deactivation of spinal extensors is a sign of muscle fatigue rather than a manifestation of the flexion relaxation response. Evidence supporting the muscle fatigue hypothesis is limited to one case-control study with a small...
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sample size. Additional research is necessary to validate this hypothesis⁴⁴.

**Over-activation of spinal extensors hypothesis**

Another hypothesis for the development of LBP in cyclists suggests that over-activation of the spinal extensor muscles may cause muscle contracture and increased tissue strain across the lumbar spine in cyclists⁴⁷. The results from a small case series study indicated over-activation of the spinal extensors, leading to muscle contracture, and this may result in tissue strain of the lumbar extensors resulting in LBP in cyclists. Activity levels of the lumbar extensors increased proportionally relative to cycling intensity¹⁵. This hypothesis, however, requires more research.

**Mechanical creep hypothesis**

Mechanical creep is a biomechanical characteristic which refers to a deformation or a change in strain of the ligament tissue which can occur over time if a constant load is applied to these structures⁴⁶-⁴⁸. Researchers suggest that mechanical creep may occur in the lumbar spine ligaments during prolonged sitting in a flexed position on a bicycle⁴⁷. Data from two animal studies showed the negative effects of creep on the visco-elastic tissues of the spine, as well as the associated muscle spasms in the multifidus muscles that are caused by sustained static flexion⁴⁹. However, in a single human study, short duration static lumbar flexion showed that creep resulted in a loss of tension in the lumbar visco-elastic tissues which was associated with muscle spasm that could indicate micro-damage to the visco-elastic tissues. In one study investigating spinal kinematics in cyclists, no evidence of creep was demonstrated. This hypothesis also requires further research.

**Disc ischemia hypothesis**

It is well established that up to the age of 8 years the intervertebral discs of a human have a blood supply, but thereafter discs are dependent for their nutrition on diffusion of tissue fluids⁵¹. Movement of the spine is thought to aid this fluid transfer in and out of the disc⁵¹,⁵². The stretched static position that the lumbar spine remains in during cycling may reduce the normal mechanism for nutrients to enter the disc and metabolic waste to move out, and thus result in ischemic pain. Intermittent cyclical loading of the disc may possibly aid fluid movement in and out of the disc, thus reducing pain⁵¹.

**Summary: Pathomechanics of lower back pain in cyclists**

In summary, a number of hypotheses have been suggested to explain the pathomechanics of the development of low back pain in cyclists. In general, there is very little scientific evidence to support any of these hypotheses, and in many instances these hypotheses seem contradictory. However, it is also possible that these hypotheses represent a continuum of the development of LBP in cyclists, but do not explain this in isolation. It is important to note that in all the studies that investigate possible pathomechanics of LBP in cyclists, the behaviour of muscles and spinal kinematics in cyclists with LBP were monitored for a short time period (less than an hour)¹⁵,³⁷,⁴⁴. It is possible that by beginning to record motor patterns after a time period exceeding one hour, and thereafter, by continuing to record over a longer period, more accurate information on the pathomechanics of LBP in cyclists will be obtained. In most instances, cycling sessions and races far exceed one hour.

A review of the possible intrinsic and extrinsic risk factors that have been associated with LBP in cyclists may provide information to determine the possible causes of LBP in cyclists.

**Risk factors associated with lower back pain in cyclists**

Although the aetiology of LBP in cyclists is still unclear, a few studies have reported possible associated risk factors. Scientific evidence to support each of these risk factors is, however, limited. In Table 1, postulated extrinsic and intrinsic risk factors that may be associated with the development of LBP in cyclists are listed. In addition, the evidence from studies to support each risk factor is listed. The evidence is depicted as ranging from Level 1 (strong evidence), to Level IV (very weak or no evidence), and is based on evaluating the studies using well-established evidence-based medicine criteria⁵³.
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Based on the findings of this analysis, it is apparent that there is very little evidence supporting extrinsic risk factors associated with LBP in cyclists. Only distance cycled, low gear usage and less years of cycling showed any association in a single questionnaire survey.

Additionally, there are few studies which present strong evidence for intrinsic factors which have a positive association with LBP in cyclists. Two intrinsic factors which are worthy of discussion are the “Pelvic tilt/ saddle angle” and “Asymmetrical spinal muscle firing patterns”. These will be discussed separately.
Pelvic tilt/saddle angle

The pelvic tilt/saddle angle has the strongest evidence for a possible risk factor associated with LBP in cyclists.

It has been suggested that a forward or anterior pelvic tilt (APT) of the cyclist’s pelvis is favourable for cycling as it may reduce the tensile forces on the lumbo-sacral spine, thereby reducing the risk of LBP in cyclists20;30. An APT and forward position of the trunk may help distribute a greater percentage of the body weight over the handlebars, thereby reducing the load on the seat and lumbar vertebrae of the spine20.

In one controlled clinical trial30 the pelvic/spine angles at different seat angles on different bicycles (10 asymptomatic subjects per bicycle) was measured by serial fluoroscopic investigations. The results of this study showed that there was a tendency towards hyperextension of the pelvic/spine angle, and this resulted in an increase in tensile forces at the promontorium. It was shown that these forces could be reduced by adjusting the seat angle to create an anterior inclining angle. The findings were then applied to a group of 80 cyclists who suffered from lower back pain. An adjustment of the saddles of these cyclists, by inclining the saddle anteriorly by 10-15 degrees, resulted in improvement in the incidence and magnitude of LBP in 70% of the cyclists30.

A downward tilted saddle would place the pelvis in an anterior tilted position. It has been shown that elite cyclists have an increased anterior pelvic tilt relative to matched non-cyclists54.

Asymmetrical paravertebral muscle firing patterns

It has been suggested that asymmetrical firing patterns of the lumbar muscles on either side of the spine may affect spinal kinematics and support37,55, and therefore be a risk factor for LBP in cyclists. In one case control study, differences in spinal kinematics and trunk muscle activity were documented in cyclists with and without non-specific chronic LBP (n=18)37. It was noted that the symptomatic group had increased lumbar flexion and rotation at the onset of cycling (pre-testing), indicating a possible predisposed risk to the development of lower back pain in cycling37. These cyclists also showed an associated loss of co-contraction of the lumbar multifidus.

A similar asymmetry in firing patterns was also shown in the lumbar erector spinae muscles in another case control study44. Cyclists with LBP were compared with cyclists without LBP (n=14). Surface EMG results showed higher muscle fatigue in the erector spinae of the lower back pain group (LBP) when compared to the controls. It was interesting to note that the LBP group had significant fatigue in the right erector spinae muscle which may indicate that there was an asymmetrical loading at the end of the ride44.

Summary and conclusion

Reports indicate that LBP is a common cycling injury although studies on the epidemiology of LBP in cyclists are limited. The cyclist’s position on the bicycle results in the spine being placed in a non-physiological flexed position for an extended period of time. This unnatural position of the spine may place excessive strain on the spine increasing the possibility of developing LBP. The correct bicycle set-up has been highlighted as an important factor in ensuring an optimum cycling position to reduce the strain on the lower back region. The significant adjustable parameters which most affect the upper body position of the cyclist are the reach and saddle angle. There is little evidence supporting existing pathomechanical hypotheses for the development of LBP in cyclists. Further studies on pathomechanics may yield more accurate data if cyclists are monitored for time periods well exceeding one hour, (which was the maximum time cycled in previous studies)15;37;44. It is possible that these hypotheses represent a continuum of the same phenomenon, and do not explain the development of LBP in cyclists in isolation or exclusively. Extrinsic risk factors for LBP in cyclists have not been studied extensively, but include increased distance cycled and training errors such as excessive low gear usage. There is stronger evidence from a single study to support the pelvic tilt/saddle angle as an intrinsic risk factors for LBP in cyclists. There is limited evidence supporting asymmetrical spinal muscle firing patterns as an additional
intrinsic risk factor associated with LBP in cyclists.

Therefore further research on the epidemiology of LBP in cycling is necessary. Additionally, further research in the form of prospective cohort and intervention studies is necessary to investigate extrinsic and intrinsic factors associated with LBP in cyclists.

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