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Article

Overuse Injuries Associated with Mountain Biking: Is Single-Speed Riding a Predisposing Factor?

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Abstract: Though mountain bikers are at significant risk for overuse injury, there is minimal quality research describing this relationship. Single-speed mountain biking, in which participants pedal a bike with only a single gear, may place riders at even greater risk for overuse problems due to the disproportionate physical effort associated with this type of riding. The focus of this study was to provide additional perspective on overuse injuries sustained by mountain bikers and to determine if single-speed mountain biking places participants at greater risk for overuse conditions. Four hundred and four (404) mountain bikers were surveyed concerning overuse injuries sustained during the previous year. Findings indicate that 63% of respondents reported an overuse injury affecting at least one area with the most commonly reported areas being the lumbar spine, knees, hand/wrist, and cervical spine. Individuals riding single-speed mountain bikes did not have a higher incidence of overuse injuries than riders of multiple-geared bikes. However, respondents who split time between riding single-speed and multiple-geared bikes were significantly more likely to report an overuse syndrome than those only riding single-speed or multiple-geared bikes (p = 0.0104). This group of riders may be at greater risk for overuse injury due to excessive fatigue and poor biomechanics.

Keywords: overuse injury; mountain biking; single-speed

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1. Introduction

The sport of mountain biking has evolved from a niche hobby to a mainstream activity in a relatively short period of time. Just a few decades ago, a small group of outdoor enthusiasts modified bicycles originally designed for riding on paved surfaces so they could efficiently travel on dirt roads and trails [1]. Though these modified rigs bore minimal resemblance to today's mountain bikes, these early pioneers were the inspiration for what is now considered a very popular outdoor activity. From 2006 to 2012, it is estimated that approximately 17% of Americans over the age of 6 participated in mountain biking in one form or another [2]. As evidenced by its inclusion as an Olympic sport in 1996, it has become a globally appreciated activity [1,3,4].

But due to the physically demanding nature of mountain biking, participants are susceptible to overuse injuries. Like road cycling, mountain riders must sustain unnatural or uncomfortable positions and engage in repetitive movements [5,6]. Off-road cycling also involves pedaling over rocks, roots, ledges, drops, and other variable terrain. These added challenges generate unpredictable vibration forces that the bike and/or the rider's body must absorb [5]. This combination of repetitive motion and micro-trauma creates tissue stress which may eventually result in overuse injury syndromes. And with a large proportion of recreational athletes participating in mountain biking, a significant number of individuals are at risk for overuse problems associated with the sport.

Though the majority of mountain biking research describes traumatic injuries, a few articles have focused on overuse syndromes sustained by participants. In the largest study of this type, Frobose *et al.* [6] surveyed 840 mountain bike festival attendees regarding overuse symptoms experienced during or after the main riding event. Ninety-percent (90%) of respondents in the study reported experiencing symptoms with the most commonly affected areas being the buttocks, cervical spine, fingers, lumbar spine, knees, and hands. Sabeti-Aschraf and colleagues [5] reported that immediately after a mountain bike race, ~52% (87/167) of riders experienced pain in at least one location with the most frequently affected regions being the lumbar spine, buttocks, and knees. Of methodological note in interpreting these findings is the fact that in these studies overuse conditions were defined as the occurrence of symptoms during one particular episode of riding at a formal mountain biking event. Dingerkus *et al.* [3] employed a more global approach and retrospectively surveyed 208 mountain bikers of various abilities regarding overuse syndromes. Forty-six percent (46%) of respondents indicated having "regular discomfort while exercising in their sport" with the spine/back and knees being the most symptomatic regions. However, the authors did not explicitly state the time frame over which participants expressed having such problems. In another study, 62% of mountain bikers reported sustaining minor injuries with the vast majority of these being classified as overuse conditions [7]. Though the incidence of reported overuse injuries in these studies varies considerably, the consistent message is that a significant percentage of individuals who ride mountain bikes tend to experience symptoms indicative of overuse injuries.

A trend in this sport is that a growing number of participants choose to ride bikes with only a single gear. Colloquially referred to as "single-speeds", these bikes have only one front chain ring and one rear chain ring and therefore prevent the rider from shifting between different cogwheel combinations. This set up differs considerably from most commercially produced mountain bikes which are configured with multiple gears that allow the rider to shift and maximize pedaling efficiency based on the riding situation at hand. Gearing ratios on single-speed bikes are most commonly oriented towards a 2:1 front to rear cogwheel relationship [8]. In other words, if the front chain ring has 32 teeth then a rear chain ring of half the size (*i.e.*, ~16 teeth) would be utilized. This arrangement is considered to be a somewhat versatile single-gear option which allows the rider to propel the bike efficiently under a wide variety of circumstances. Nonetheless, without the ability to shift into a gear which maximizes pedaling efficiency, a single-speed rider will usually expend more physical effort than a rider on a multiple-geared bike. Another distinguishing feature of single-speed bikes is that they typically have only a front suspension system. This suspension arrangement permits a maximum transfer of forward energy during each pedal stroke without the additional vertical bobbing of a rear shock absorber. Proposed reasons that some riders opt for single-speed mountain bikes include a preference for mechanical simplicity, less required bicycle maintenance, and the desire for the increased challenge associated with propelling a bike without multiple gears [9]. Regardless, the increased popularity of single-speed riding is evident, as noted by the inclusion of a single-speed racing category at many high profile mountain biking events [10].

Because single-speed mountain biking requires a greater physical effort, it is possible that this type of riding increases the risk of developing an overuse injury. As previously mentioned, under certain conditions single-speed bikes are less efficient than multiple-geared mountain bikes. This is especially true when climbing steep ascents, maintaining speed while descending, and pedaling powerfully through excessively technical terrain. Literature supports that the additional resistance associated with pedaling in a difficult gear has the potential to cause greater stress on body tissues and increase the risk of developing an overuse syndrome [11].

To date, there are no published studies examining the relationship between single-speed mountain bike riding and the development of overuse injuries. In addition, the methodology of existing research on mountain biking allows for limited conclusions regarding participants' risk for developing overuse conditions. Therefore, the research questions guiding this study were: (1) What is the incidence of overuse injuries sustained by mountain bikers of various demographics over a defined period of time; and (2) Do individuals who ride mountain bikes with a single gear report more overuse injuries as compared with those who ride mountain bikes with multiple gears? The hypothesis was that participants who ride single-speed mountain bikes would report significantly higher amounts of injuries as compared to those who only ride multiple-geared mountain bikes.

2. Methods

An online survey based on published literature describing mountain biking and self-reported injuries was designed to gather data regarding mountain biker characteristics and any overuse injuries they sustained [3,6,7,12,13]. Survey items primarily consisted of closed-ended questions which could be classified as categorical data. Prior to use in the study, the survey was piloted among ten experienced riders and based on feedback, modified accordingly. The final version included questions about personal demographics, characteristics of respondents' mountain bikes, riding volume, riding style, and any mountain bike related overuse injuries sustained during the past year. More specifically, participants were asked about their age, gender, race, the gearing and suspension systems on their mountain bikes, the estimated number of hours ridden per week, types of trails typically ridden, and in which if any, body regions they experienced symptoms of an overuse injury. Within the survey, overuse injuries were defined as "the presence of pain, discomfort, swelling, bruising, or any other uncomfortable symptom which may have occurred as a result of sustained cycling but did not result from a crash".

To maximize recruitment, emails containing a description of the study, eligibility criteria, and a link to the survey were sent to mountain biking enthusiast list-servs. This information was also sent directly to email addresses collected from riders attending formal and informal mountain biking events throughout the state of Arizona. Participant responses were considered eligible for analysis if they were sufficiently complete, if they reported riding multiple days per week during their most active periods, and if they indicated that the majority of their riding occurred within the state of Arizona. The last criterion was implemented to create a more homogeneous population of respondents with respect to the general type of terrain ridden.

Responses from 404 mountain bikers were deemed appropriate for analysis. Seventy-eight percent (78%) of these individuals were male, 22% were female, and the mean respondent age was 40. (See Table 1 for summary of all participant demographics.) Using this information, a logistic regression model was constructed to determine associations between possible explanatory variables and reported overuse injuries. Included in this model were main effects of gender, riding volume, suspension type, and gear type. This model was constructed with the following principles in mind. Because respondents were asked to choose from multiple time periods representing their estimated number of hours ridden per week, this variable, like gender and gear type, was categorical in nature. Riding volume, suspension type, and gender were included as covariates based on literature describing these variables as potential overuse injury risk factors [14,15]. Gear type was subdivided into three categories. These included individuals who reported only riding single-speed mountain bikes (SS), those who reported that they only rode bikes with multiple gears (MG), and those who reported spending a significant amount of time riding both single-speed and multiple-geared mountain bikes (SS/MG). Inclusion of this variable was essential because its influence on overuse injury was a central purpose of the study. Suspension type was also subdivided into three categories. These included full suspension (front and rear shock absorber), front suspension (front shock absorber only), and no suspension (absence of shock absorbers). Because it was possible for individuals in the SS/MG group to ride mountain bikes with two differing suspension types, these participants were classified as the suspension type associated with the bike on which they indicated they performed the majority of their riding. Interaction effects between these variables were not included in the final model to minimize unnecessary hypothesis testing which is associated with inflation of type I error and due to minimal theoretical basis for examining these relationships.

Table 1. Demographics of mountain bikers responding to the survey.

Gender	314 Males (78%) 90 Females (22%)
Age	Range 19–76 Mean 40
Race	369 Caucasian (92%) 16 Hispanic(4%) 12 Other (3%) 5 Asian (1%) 1 Native American 1 Pacific Islander
Gear Type	57 Single-speed (SS) 280 Multiple Gear (MG) 67 Both (SS/MG)
Suspension Type Single-speed Bikes	4 Full Suspension (3%) 84 Front Suspension (68%) 30 Without Suspension (24%) 6 “Other” (5%)
Suspension Type Multiple-geared Bikes	218 Full Suspension (63%) 109 Front Suspension (32%) 12 Without Suspension (3%) 8 “Other” (2%)

3. Results

When considering all anatomic areas included in the survey, statistical analysis with logistic regression indicated no significant differences in overuse injury syndromes sustained by SS riders (59%) as compared to MG riders (63%). However, 78% of individuals who reported spending a substantial amount of time riding both types of bikes (SS/MG) reported sustaining an overuse injury in at least one area of the body. As compared to the other two groups, this difference was statistically significant (p = 0.0104). Though a trend was noted for gender, significance was not found for this variable or riding volume. A significant association between suspension type and overuse injury was also found (p = 0.0016) with full or front suspension carrying a greater risk of overuse injury than the absence of suspension. Follow up logistic regressions by individual anatomic region revealed no significant differences in the risk of developing an overuse injury in any specific body part. However, there were trends associated with a higher incidence of knee, back, and neck pain in the SS/MG group. These findings are summarized in Table 2. Calculation of odds ratios revealed that the odds of overuse injury were approximately twice as high for those riding SS/MG bikes than for those only riding SS bikes (1.96). Furthermore, the odds of overuse in SS/MG riders was over two and one-half times that of those riding only MG (2.69) bikes (Table 3). When considering overuse injuries within the group of riders as a whole, the most commonly reported conditions were those affecting the low back, knee, hand/wrist, and neck/upper back. The incidence of overuse syndromes categorized by group (SS, MG, SS/MG) as well as the entire group of riders are summarized in Table 4.

Table 2. Effect of gender, gear type, and riding volume on overuse injuries.

	All Injuries	**Back Injury**	**Neck Injury**	**Knee Injury**
Variable	Percentage of observations P Value			
Gender	Male 61% Female 68% 0.0848	Male 24% Female 22% 0.8882	Male 16% Female 16% 0.6521	Male 23% Female 26% 0.6662
Gear Type	SS 63% MG 59% SS/MG 78% 0.0104	SS 23% MG 21% SS/MG 34% 0.0864	SS 14% MG 14% SS/MG 24% 0.2242	SS 25% MG 20% SS/MG 34% 0.0651
Riding Volume (h/week)	≤8 56% 8–16 65% >16 73% 0.1172	≤8 20% 8–16 26% >16 27% 0.5410	≤8 12% 8–16 17% >16 27% 0.1020	≤8 24% 8–16 23 >16 22% 0.7974
Suspension	Full 62% Front 69% None 40% 0.0016	Full 25% Front 23% None 18% 0.3926	Full 19% Front 16% None 5% 0.0348	Full 19% Front 29% None 20% 0.1370

Table 3. Odds ratios associated with overuse injury.

	ALL INJURIES	**Back Injury**	**Neck Injury**	**Knee Injury**
	Odds Ratio (95% Confidence Interval)			
Female *vs*. Male	1.58 (0.93,2.72)	1.04 (0.57,1.85)	1.19 (0.59,2.29)	1.13 (0.63,1.98)
SS/MG *vs*. MG	2.69 (1.40,5.47)	2.03 (1.09,3.75)	1.88 (0.92,3.76)	2.10 (1.12,3.89)
SS/MG *vs*. SS	1.96 (0.85,4.58)	1.59 (0.70,3.71)	1.51 (0.57,4.25)	1.84 (0.83,4.23)
MG *vs*. SS	0.72 (0.35,1.45)	0.78 (0.36,1.74)	0.81 (0.32,2.16)	0.88 (0.42,1.89)
8–16 h/wk *vs*. ≤8 h/wk	1.47 (0.93,2.32)	1.34 (0.80,2.28)	1.49 (0.80,2.84)	0.92 (0.55,1.54)
>16 h/wk *vs*. 8–16 h/wk	1.33 (0.65,2.84)	0.94 (0.44,1.91)	1.70 (0.77,3.59)	0.83 (0.37,1.75)
>16 h/wk *vs*. ≤8 h/wk	1.94 (0.94,4.25)	1.26 (0.56,2.72)	2.53 (1.07,5.88)	0.76 (0.33,1.67)
Full *vs*. Front	0.88 (0.54,1.43)	1.18 (0.69,2.02)	0.71 (0.38,1.30)	0.63 (0.37,1.06)
Full *vs*. None	3.39 (1.56,7.61)	1.89 (0.77,5.21)	5.40 (1.43,35.69)	1.12 (0.47,2.94)
Front *vs*. None	3.84 (1.83,8.30)	1.61 (0.68,4.28)	3.83 (1.05,24.73)	1.79 (0.79, 4.50)

Table 4. Incidence of overuse injury by anatomic region. (** Statistically Significant at alpha = 0.05).

	All	**MG**	**SS**	**SS/MG**
Any injury	63%	59%	63%	78%**
Neck/Upper Back	16%	15%	14%	24%
Low Back	24%	21%	23%	34%
Shoulder	6%	6%	5%	6%
Elbow	7%	8%	5%	4%
Hand/Wrist	18%	18%	14%	19%
Saddle Region	15%	13%	26%	15%
Hip/Groin	7%	6%	12%	7%
Knee	23%	20%	25%	34%
Ankle/Foot	6%	6%	4%	7%

4. Discussion

Individuals in the SS/MG group were significantly more likely to report an overuse injury when considering conditions affecting all possible anatomic regions. When analyzing specific anatomic areas, SS/MG riders were significantly more likely to report having knee pain as compared to the SS or MG groups. These findings were somewhat surprising. Considering the increased physical demands associated with riding a single-geared mountain bike, the investigators hypothesized that the SS group would report the greatest amount of overuse injuries.

Though the data and study design do not allow for a specific rationale explaining these findings, there are logical reasons why those riding both types of bikes might be more susceptible to overuse injuries. It is quite possible that SS and MG riding are associated with differing biomechanical demands. Individuals who do not spend sufficient time training in each style of riding may not develop the necessary strength, power, and motor patterns to minimize the body and tissue stress associated with overuse injury. Again, this study in and of itself does not provide an explanation for the findings. But based on further review of the literature, the authors offer the following hypotheses.

The gearing configuration of a single speed bike suggests that this type of riding should require different strength, power, and pedaling patterns as compared to bikes which allow the rider to choose the most efficient gear for the terrain. During uphill climbs, it is common practice for cyclists to employ various strategies such as standing while pedaling, rocking side to side, and pulling upwards on the handlebars in an attempt to overcome the additional gravitational forces [16–18]. Though the use of these strategies has not been specifically studied in single speed riders, it stands to reason that these same strategies would be employed by individuals riding single-geared mountain bikes because they lack the ability to reduce cycling effort by shifting into an easier gear. Due to specificity of training [19], individuals riding only single-speed bikes have the potential to develop adequate strength and balance and learn efficient body positioning during these maneuvers. However, those splitting time between single and multiple-geared riding may not achieve the same level of physical training, experience greater tissue micro-trauma while riding, and thus have greater potential to develop an overuse problem.

Knee pain appears to be the overuse condition most dramatically affected by SS/MG riding and literature suggests that this outcome may be related to fatigue which is excessive to the point of affecting a rider's cycling mechanics. The most commonly reported cause of knee pain among cyclists is patellofemoral pain syndrome [20]. This condition is caused by abnormal stress within the patellofemoral joint which results from poor biomechanics during knee motion [11,21]. The relationship between excessive fatigue and a corresponding progressive change in biomechanics during athletic performance is well documented. Studies in which athletes are physically pushed beyond lactate thresholds or to voluntary exhaustion clearly demonstrate that these levels of fatigue are associated with significant changes in biomechanics [22–26]. Furthermore, there is considerable evidence that excessive fatigue has the same effect on cycling mechanics [21,27–30]. For example, Dingwell *et al*. [31], specifically confirmed that pedaling to exhaustion on a stationary bicycle ergometer resulted in cyclists demonstrating altered trunk, hip, knee, and ankle kinematics during subsequent pedaling. Similarly, Abt *et al*. [32] had subjects perform exercises that fatigued core muscle groups which control trunk motion. The authors found that exhausting these areas also significantly altered cycling mechanics at the knee and ankle. Based on this information, it stands to reason that mountain bikers with inefficient riding patterns could exhibit such altered mechanics and be predisposed to developing knee pain or other overuse conditions. Relating these findings to the present study, it is possible that individuals in the SS/MG group became more severely fatigued when riding their single geared bikes. Once excessively fatigued, these participants may have experienced altered cycling mechanics which as previously stated, increase the risk of overuse injury [33,34]. Consequently, dedicated single-speed mountain bike riders may have become better physically conditioned due to regular exposure to such physically demanding riding. This training, in turn, may have limited excessive fatigue and allowed them to minimize the altered mechanics associated with such exhaustion. Admittedly, all cyclists will experience some degree of fatigue. However, considering the increased physical effort associated with pedaling higher gears, as occurs on a single speed bike [11], SS/MG riders not accustomed to such levels of exhaustion may reach excessive fatigue sooner when riding with a single gear and demonstrate altered movement patterns and poor joint mechanics during a greater percentage of their riding.

The greatest proportion of the variance in overuse injuries among respondents was associated with suspension type. Literature describing the relationship between mountain bike suspension and overuse conditions is somewhat inconclusive. Though in theory, suspension is proposed to dissipate impact and vibration forces [5,6], previous studies have failed to identify this variable as a statistically pre-disposing factor [3]. Odds ratios in Table 3 suggest that despite the potential for suspension to provide protection against impact, riders with full and front suspension seemed to be at greater risk for developing overuse problems. This relationship between suspension type and overuse may warrant further study. Nonetheless, when considering the influence of suspension as a covariate in the statistical model, gear type still has a significant association with self-reported mountain biking related overuse injuries.

The variation between the incidence of overuse injury reported in this investigation and those described in previous studies may be associated with differing methodologies. The 63% incidence of reported overuse problems for all riders surveyed in this study is considerably lower than the 90% incidence reported by Frobose *et al*. [6] These investigators asked participants to describe pain or problems experienced during or just after a riding event. With a limited reporting period such as this, a greater number of riders would be expected to report experiencing pain. This is because such complaints might be a temporary symptom rather than a true, ongoing overuse problem. However, using a similar methodology, only 55% of subjects in the study by Sabeti-Aschraf reported symptoms during or immediately after a structured biking event [5]. In an attempt to identify overuse syndromes which were representative of persistent problems, the investigators in this study asked subjects to report any painful conditions they could recall experiencing over the past year. Dingerkus *et al*. [3] also asked participants to report problems sustained over a period of time. The incidence of overuse conditions reported in that study was 46%, but because researchers did not indicate the amount of time over which these individuals experienced problems, comparisons are difficult.

The anatomic regions in which participants in this study most commonly reported problems were the low back (24%), knee (23%), hand/wrist (18%), and neck (16%). Among the SS/MG group—who reported the most overuse syndromes—injuries were most numerous in the low back, knee, and neck regions. It should be noted that these frequencies could be influenced by the use of survey methodology. Using retrospective, self-report data has been the primary means used to measure as the incidence of overuse injuries in the mountain biking literature [3–6]. Though the authors of this study attempted to maximally operationalize these procedures, allowing respondents to determine whether or not they have experienced an overuse problem allows for a certain level of interpretation and subjectivity. The use of a web-based survey also prevents determination of the overall response rate. Therefore, it was not possible to assess the potential for non-response bias in which the presence or absence of an oversuse injury might influence whether or not an individual opts to respond to the survey[35]. Furthermore, it has been proposed that mountain bikers, as a group, trivialize symptoms and may under report complaints of pain associated with overuse [6]. For these reasons, future research efforts based on a prospective design would permit more generalizable conclusions.

Nonetheless, the most commonly reported problems by anatomical area described in this study are consistent with those reported by other authors and are therefore worth further consideration [3,5,6]. The literature describing overuse injuries in road cycling describes possible etiologies for these conditions. The prolonged, flexed position sustained by cyclists is thought to induce lumbar spine pathology via mechanisms such as spinal extensor hyperactivity, elongation stress on non-contractile structures, or decreased movement of fluid in lumbar discs [36]. The latter mechanism is thought to result in ischemic pain due to insufficient nutrient and oxygen delivery and an accumulation of waste products [20,37]. Similarly, neck problems may result from the prolonged cervical hyperextension needed to view the road or trail ahead. This position may cause upper trapezius and levator scapulae hyperactivity and spasm or compression of the cervical facet joints [20]. Knee pain is most commonly thought to occur due to large reaction forces at the patellofemoral joint which occurs when cyclists exhibit abnormal cycling mechanics [33,34] or pedal in too difficult of a gear [11,20,21]. Lastly, hand and wrist pain is commonly attributed to extended upper extremity weight bearing on the handlebars which consequently, stresses ligamentous, muscular, and nervous tissues [38].

The findings of this study suggest the following clinical implications. The primary conclusion is that participants in this study who reported riding both single-speed and multiple-geared mountain bikes were also more likely to report an overuse injury than those only riding either type of bike. Again, due to the limitations associated with survey research and self-report data, further research in the form of prospective studies would help determine the strength of this relationship. However, awareness of the patterns noted in this study may be of benefit to health care providers, coaches, personal trainers, and others involved in training or providing care for athletes. Specifically, this information could help educate mountain bikers regarding training in a manner which helps avoid the onset of overuse syndromes. It is well beyond the scope of this article to provide in depth training recommendations. But in general, literature suggests programs focusing on recruitment of trunk and abdominal muscles, hip extensor and abductor muscle groups, and deep cervical flexor musculature are effective for managing or preventing overuse conditions affecting the low back, knees, and neck respectively [39–42]. Though more research is needed, athletes riding both single-speed and multiple-geared bikes may benefit from training regimens to avoid developing overuse problems affecting these areas. Those that begin to develop overuse symptoms may consider focusing their training and/or recreational mountain biking on one type of riding or the other.

5. Limitations

This study has several limitations, some of which have been previously discussed. The retrospective nature of survey data collection is a limitation because in this design, it is not possible to implement prospective experimental controls. Though the utilization of the internet to distribute surveys permitted greater access to potential participants, using this forum prevents analysis of response rates [43]. Therefore, it was not possible to determine if the response rate was sufficient to allow generalization of findings. Furthermore, all survey research is subject to non-response bias [35]. The implication of this in the present study is that the presence or absence of an overuse injury may have influenced whether or not the individual chose to complete the survey. Though the onset and presence of overuse injury was operationalized in this study to a greater extent than in previous literature, minimal standards exist for defining such conditions among a population of mountain bikers. Therefore, the presence of an overuse syndrome was determined by the participant's own subjective interpretation of the definition provided within the survey. If properly performed, bike fit has been described as a factor which contributes to the onset of overuse injuries [5]. Data collection through the use of a survey tool prevented researchers from verifying if participants' bikes were fitted in a valid manner. Thus, the influence of bike fit on the results is not known. Finally, because it was not possible to control for engagement in physical activities other than mountain biking, participation in other sports may have had an influence on overuse injuries.

6. Conclusions

Because both mountain biking and single speed riding have become popular among competitive and recreational athletes, it is important that health care providers, coaches, and trainers be familiar with participants' risk for sustaining an overuse injury. The findings of this study suggest that mountain bikers are most at risk for overuse injuries affecting the low back, neck, hand/wrist, and knees. Individuals who split time between riding single-geared and multiple-geared mountain bikes seem to have the greatest risk for developing an overuse syndrome. This is especially true with respect to conditions affecting the knee. These findings may be attributed to riders who are not as well trained in single-geared riding tiring quicker than dedicated single-speed riders. Consequently, these individuals may exhibit abnormal riding mechanics induced by fatigue above and beyond normal levels which has potential to result in overuse injury.

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Conflicts of Interest

The authors declare no conflict of interest.

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