

Ergonomic Interventions, Health and Injury Prevention during Off-Road Mountain Biking

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Editorial

Half of all Americans participated in outdoor recreation activities during 2013, of which 16% or 46.6 million (older than 6 yrs) take part in cycling (Road, Mountain bike, or BMX). Excursions totalled at 2.7 billion and ranked it 2nd for number of outings (887.9 million) for ages 6-17 yrs [1]. This presents a positive picture in regards to health promotion, yet there are concerns regarding bone health and excessive time spent in a weight supported position in road cyclists [2]. On the other hand, mountain bikes are the most popular bike ridden in the western world [3]. This discipline of cycling not only improves cardiovascular health, but also provides an osteogenic effect greater than both road cycling and normal recreational activity [4].

However, this sport does come with it's own risk and the overall injury rate is classed as very high, with 16.8 injuries per 1,000 h exposure [5]. While the majority of these injuries are acute, traumatic, and isolated to the minority [3], it is expected that many overuse injuries are not reported. This is supported by data showing 51.4% of participants completing an endurance mountain bike race suffered symptoms of overuse, particularly in the lower back, buttocks, knees and wrists [6]. Similarly, participants exposed to 4h of intense mountain biking suffered benign paroxysmal positional vertigo without any prior symptoms [7].

Purportedly, such negative effects are primarily due to the non-propulsive work demand caused by shock attenuation, a consequence of negotiating obstacles, and the continuous damping of vibrations. These vibrations are produced via the interaction of tyre surface area with trail surface [8] and are the very same thing that promote the sports osteogenic effect [4]. As such, the vibrations mountain bikers are exposed to are complex in nature, containing many frequencies (generally <50 Hz) in all directions and ranging in amplitude (rms) from 15-20 m·s⁻¹ at the handlebar and 20-30 m·s⁻¹ at the seat post [8]. The energy from such oscillating movements must be absorbed or else result in little or no wheel contact, albeit for a very short period of time. Even so, during these small epochs, the transfer of energy from the drive mechanism to the tyre-trail surface interaction cannot occur.

In order to negate this negative effect, the bikes mechanical parts and bike rider's soft tissue, absorbs energy in a damping mechanism enabling more efficient forward momentum and thus prevents injury to the axial skeleton. This occurs in the mechanical-biological system, particularly at the point of contact including handlebar-arm; pedal-foot-leg; and saddle-lower back [8]. It is reflected by an increase in upper body muscular work done [9] and likely plays a part in overall

decreased economy during off-road compared to road cycling. The continuous nature of which leads to overuse injuries at the joints.

Therefore, the challenge for the mountain bike industry is to provide a bicycle that interacts in the most efficient and safe manner with regards to performance and comfort. As such, product research and development is obviously critical within the industry, yet little information is presented in a scientific manner through peer reviewed processes. This means the sport is industry driven, begging the question regarding conflict of interests between trying to sell new products and providing the customers with the best experience.

Mountain biking's roots are entwined in the use of bicycles for off-road commuting during the 1890's. However, these bicycles and their cyclocross cousins of the 1940's and current day, offer riders quite a different experience with regards to comfort and performance compared to present day mountain bikes. The individual experimental transformation of such bikes included frame geometry, tyre volumes, saddles, handlebar and handlebar grips, wheelsize, suspension systems, frame and component construction, a reversion to bigger wheels and the wider wheel.

Interestingly, the main emphasis of research has focussed on suspension systems, with initial results concluding that front suspension (HT) and full suspension (FS-front and back) are both effective at increasing rider efficiency over bumpy terrain [10,11]. Corroborated by laboratory studies that identified significantly increased efficiency and comfort of FS bicycles [12]. It is likely that the reduction in work done is a direct result of the capability of the mechanical system to reduce vibration exposure to the rider [13]. While this is positive for recreational riders with regards to reduced injury risk and improved comfort. There have been concerns that the additional weight of both the FS and HT systems and the power dissipation within the system, will reduce athletic performance [14]. It is important to recognise that technological development of bicycle suspension has improved considerably since these papers were published. As such it is envisaged that previous negative losses of energy have been reduced considerably. More recently, reductions in vibration exposure amongst competitive cyclists have been associated with a reduction in both propulsive and non-propulsive work done, thus justifying further work in this area.

Recognising the popularity and health benefits of such activities, the potential non-traumatic risks to participants, and the possible performance enhancement for elite athletes advocates the importance of ergonomic research in this area. The results of which would enhance enjoyment, performance and alleviate some of the current burden on the health systems around the world.

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