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Quantification of vibrations during mountain biking

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Abstract

Background: During cross-country mountain biking, riders are subjected to vibrations due to the terrain, which must be damped before reaching the central nervous system. Damping vibrations requires work, which may help to explain the decrease in economy for mountain biking as compared to road cycling (Titlestad et al., 2006 Journal of Sports Sciences, 24(2), 125-135). Purpose: To describe the relationship between vibration mechanics and their interaction with terrain, bicycle and rider during a race pace effort on a cross country mountain bike track.

Methods: Participants (n=8) completed two separate laps on a cross country track using 26" and 29" wheels, at race speed. Power, cadence, speed, heart rate, and geographical position were sampled and logged every second for control purposes. Tri-axial accelerometers located at handlebar centre, lower left arm, lower left leg, seat post, lower back and medial forehead, recorded accelerations with a output rate 128 Hz to measure vibrations experienced during the whole lap and over terrain sections (uphill and downhill). Vibrations were quantified using a root mean square (RMS) and using Fourier analyses.

Results: RMS data showed greater total accelerations for 29" vs 26" wheels (p=0.0020), and a significant interaction of terrain and accelerometer location (p<.0001). While climbing, accelerations were generally low and concentrated at low movement frequencies. While descending, however, high RMS values were seen on the bicycle (handlebar and seat post) and the parts of the body near the interface with the bicycle (left arm and left leg), while lower accelerations at the lower back and head were not significantly different than the accelerations during climbing. In addition, Fourier analyses showed that the accelerations occurred at a higher frequency when compared to uphill sections. No differences between overall power output (p=0.3062) and heart rate (p=0.8423), yet overall time was greater for 26" compared to 29" wheels (p=0.0061). Discussion: The results show that mountain bikers are subjected to large accelerations, or vibrations, particularly during downhill sections. These vibrations are damped before reaching the lower back and head, which requires metabolic work. In addition, 29 inch wheels showed a clear performance advantage, going faster for the same average power, although resulting in greater vibrations for the riders.

Conclusion: This study demonstrates an additional non-propulsive, muscular challenge to riding during cross country mountain biking represented by a change in accelerations at the point of interface between bike-body compared to lower back and head.

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