Evaluation of comfort: Acceleration transmissibility of different road bikes

William Bertucci, Frédéric Puel, Benoit Jarlot, Frédéric Grappe, Sebastien Duc

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BOOK OF ABSTRACTS Open Access

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W Bertucci[1]✉, F Puel[1], B Jarlot[1], F Grappe[2,3], S Duc[1]

Abstract

Background: Cycling training volume is very important for professional cyclists. According to Pinot and Grappe (2014), a top-10 cycling Grand Tour finisher rides ~30,000 km and 950 h during one complete season. In this condition several factors can induce muscular injuries or fatigue such as training load, number of competitions, quality of the recovery, and posture adopted on bike. One possible additional factor for increasing this risk is related to the vibration exposure encountered during cycling on cobblestones. According to the norms and guidelines used in the world of work (e.g. EN-ISO-5349-1, 2001), this vibratory exposure could theoretically only be tolerable for seven minutes (Chiementin and al., 2011; 2013), which is very low compared to the total time spent on cobblestones during a classic cycle race like Paris-Roubaix (~1.5 h). It has been shown also that settings (tyre pressure) and bike components (frame, wheels and fork) play a key role in the transmissibility of the mechanical vibrations to the cyclists' hands and buttock (Lepine et al., 2014). Thus to reduce the vibratory dose suffered by the cyclists, it seems interesting to choose the most appropriate settings and bike components in order to prevent muscular injuries or fatigue and, potentially, to increase cycling performance.

Purpose: The aim of this study was to assess acceleration transmissibility from the tyres to the handlebar and the seatpost on different road bikes designed or not with damping systems against vibration exposure encountered on cobblestones.

Methods: Five different carbon bikes (Table 1) have been tested on a vertical vibration plate (Physioplate Fit, Globus, Domino Srl, Codognè, Italia). The vibration (from 15.8 to 56.7 Hz) was applied successively under the front and the rear wheel. All the tests were performed by the same cyclist in the same body position and with wheels inflated to 7 bars. Three triaxle accelerometers (1350 Hz, Hikob Fox, Hikob, Villeurbanne, France) were firmly mounted on the vibration plate, the stem and the seat post (Figure 1). Transmissibility has been computed from the ratio between the root mean square (RMS) measured on the stem (output) to the RMS measured on the vibration plate (input).

Results and Discussion: Figure 2 shows that the sensitivity of the protocol proposed in the present study was able to determine differences between bikes, even if the bikes were built in the same material (carbon) or made by the same manufacturer (Table 1). Therefore, it would be used by manufacturers to optimize the comfort and the performance of their bikes, and also by cyclists to choose the "best" bike configuration to minimize the vibration exposure. Nevertheless, this choice should be confirmed by tests in actual conditions in order to evaluate the comfort and the sensation the cyclist experiences according to the racing configuration. Moreover it is quite surprising that bikes designed with damping systems (bike 1 to 3) did not always present the lowest transmissibility values, especially for low frequency vibrations (< 32 Hz). Further studies should be conducted in order to explain these differences.

Table 1. Characteristics of the five bikes studied

Bike	Damping system in the frame/bike	Road cycling usage	Manufacturer
1	On the top tube	Classic race	A
2	In the fork, the seat tube and the seat stays	Classic race	B
3	At the junction between the top and seat tubes	Classic race	C
4	Without damping system	Mountain race	B
5	Without damping system	Mountain race	A

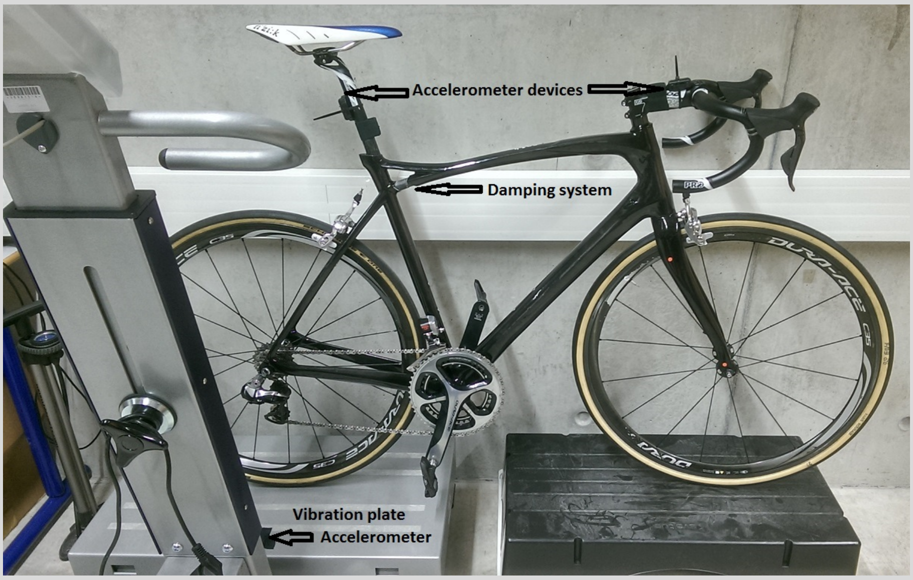

Figure 1. Experimental set-up (bike 1, without the cyclist)

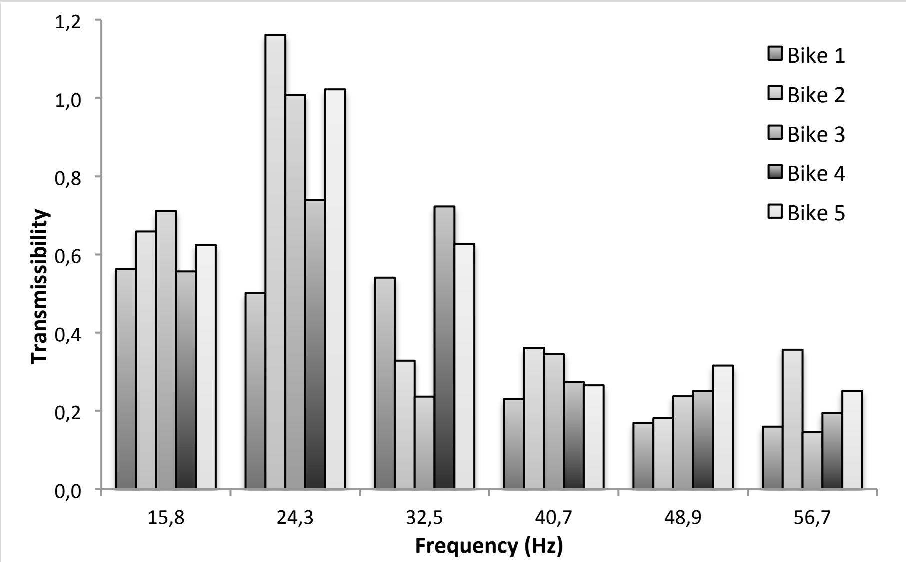

Figure 2. Transmissibility stem/platform assessed on the five bike

✉ **Contact email:** william.bertucci@univ-reims.fr (W. Bertucci)

[1] GRESPI EA 4696 / UFR STAPS, University of Reims Champagne Ardenne, France
[2] Health & Sport Department, University of Franche-Comte, EA 4660, Culture – Sport –Health – Society (C3S), Besancon, France
[3] FDJ.fr Professional Cycling Team, Moussy le Vieux, France

Journal of Science and Cycling

Breakthroughs in Cycling and Triathlon Sciences

Special number: World Congress of Cycling Science 2015, 1/2 July 2015, Utrech

Editors: Mikel Zabala (PhD)
Greg Atkinson (PhD)

Science & Cycling
1 & 2 juli 2015, Utrecht

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