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Vibration exposure on cobbles sectors during ParisRoubaix

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Abstract

Background: Paris-Roubaix is a unique and singular race of UCI World Tour. Compared to other “classic races”, the difficulty of the route is increased by the mechanical vibrations encountered during many cobbles sectors. These ones represent ~20% of the total distance to be covered (~250 km). They are classified by the organizers according to their length and the cobble’s characteristics from “easy” (two stars) to “very hard” (five stars). Previous studies measured vibration exposure at cyclist’s hand on one single cobbles sector [1] and for whole body on short urban road path [2]. Thus, the vibration exposure of cyclists during a whole race that includes many cobbles sectors remain unknown.

Purpose: The aim of this study was to measure the mechanical vibrations encountered on cobbles sectors of a “classic race” according to the norms used in the working world (ISO 2631-1, 1997; ISO 5349-1, -2, 2001).

Methods: One male cyclist (1.80 m; 68 kg) participated in the 139-km route of the “ParisRoubaix Challenge 2015” [a]. This race included 15 of the 27 cobbles sectors of the official professional course. Two tri-axial accelerometers (HiKoB Fox, HiKoB, Villeurbanne, France) were firmly mounted on the stem and the seatpost of the subject’s bike (Roubaix Expert carbon, Specialized, USA; tyre pressure set at 5.0 bar). According to the norms and previous results [2], only vertical accelerations (normal to the stem and longitudinal along the seatpost, sampled at 1350 Hz) were used to assess the effective values of vibrations. Cycling speed and heart rate (HR) were measured continuously with a GPS device (Garmin Egde 800, Garmin, Kansas City, USA). Power output (PO) and pedalling cadence (PC) were measured every 1-s with a PowerTap Hub SL+ (CycleOps, USA) and pedalling data were logged on the GPS device. For each sector, the effective value of the acceleration (RMS, $m.s^{-2}$) and the vibration dose value (VDV, $m.s^{-1.75}$) were computed from the raw acceleration subtracted by its mean value (freeing it from the orientation of the sensor). Pearson’s regressions were performed to analyse the relationship between RMS and cycling speed during cobbles sectors.

Results: The total length covered for the 15 cobbles sectors analysed was 28.1 km at a mean speed of 21.8 $km.h^{-1}$. Distance, speed, HR, PC, and PO during cobbles sectors were distributed from 0.51 to 3.69 km, 19.1 to 27.8 $km.h^{-1}$, 122 to 155 bpm, 79 to 87 rpm, and 167 to 235 W, respectively. Figure 1 shows that vibration dose value measured at stem (hand) and seatpost (whole body) seems to increase with the cobbles sectors difficulty. The RMS value increased significantly ($p < 0,001$) with the mean speed (Figure 2). According to the European guidelines (2002), the time periods needed to reach the value of exposure which triggers the action (TEAV, s) and the limit exposure value (TELV, s) were for whole body: 10 ± 3 s and 52 ± 14 s, respectively; and for hands: 153 ± 29 s and 610 ± 116 s.

Discussion and Conclusion: According to RMS and VDV values, vibration exposure is much higher at hands than at the cyclist’s seat, regardless the speed and the cobbles sector difficulty. VDV measured at seatpost are at least two times higher than values reported previously in road biking on urban path combining asphalt and pavement [2]. Limit exposure values are reached within minutes that is much fewer than the total time spent on cobblestones by professional riders during Paris-Roubaix race (~90 min). The question remains about the cyclist’s adaptations to this traumatic vibration exposure by adopting an appropriate posture or by increasing muscle work for damping vibrations.

[a] Paris-Roubaix Challenge is a Cycling for All event of UCI that take place the day before ParisRoubaix for elite riders.

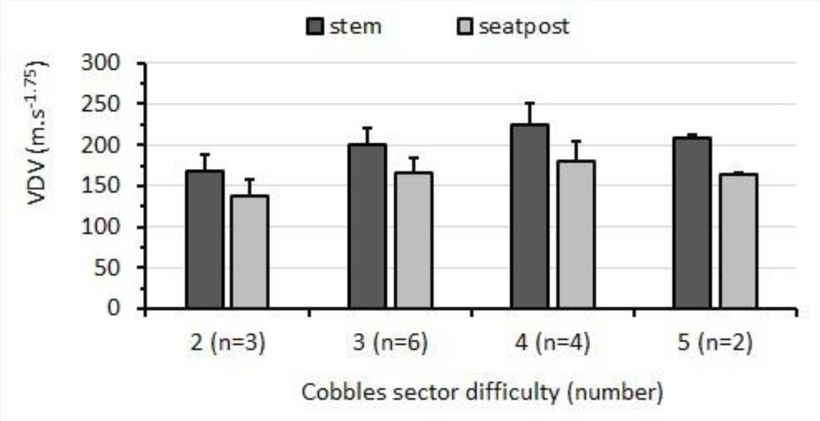

Figure 1: Vibration dose value function of cobbles sectors difficulty.

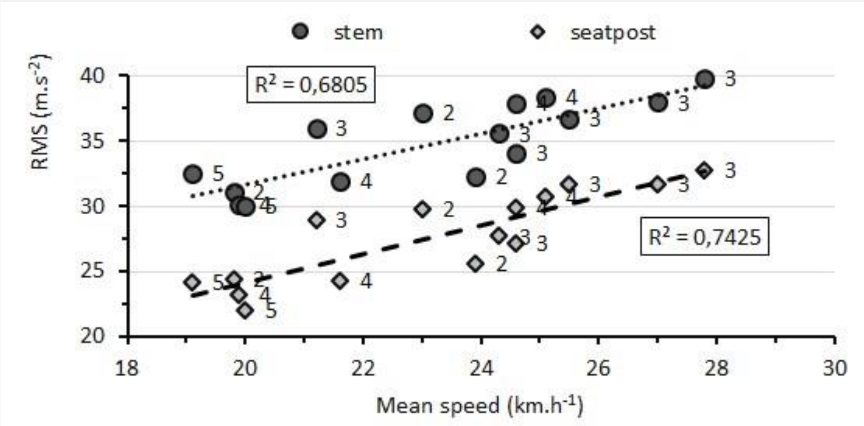

Figure 2. Linear relationship between RMS value and mean speed.
Difficulty of each cobbles sector is indicated by the number to the right of the mark

Key words
road cycling, cobbles, accelerometer, vibrations, norms

References

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