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## Classification of elite female cyclists sessions and the impact of menstrual cycles

Carlin, H., Storme, F., Chassard, T., Durmion, G., Toussaint, J.F., Antero, J.

Institut National du Sport, de l'Expertise et de la Performance

### INTRODUCTION:

The menstrual cycle of female athletes may impact training effort, particularly those in high intensity[1]. We aimed to i) classify the training sessions of elite female cyclists based on the power meter data of each session to ii) identify the effect of the menstrual cycle phases on the different types of training sessions.

### METHODS:

13 elite cyclists volunteered to participate in the study. They declared the beginning and the end of their menstrual periods and the other phases of their cycle were determined relying on a prediction method[2]. Three phases make up the female hormonal cycle: the menstrual period is the first phase, followed by the follicular phase which ends with ovulation and begins the luteal phase where progesterone level is highest. Eight of the 13 cyclists met the criteria of a regular cycle between June 2017 and November 2022. A total of 2,858 cycling sessions were then collected during this period of follow up. A principal component analysis (PCA) was implemented to determine the variables the most discriminants of the effort performed by the cyclists. 14 external load variables were then selected, (e.g., session distance, time, average speed and power, Coggan loads). Then a K-means Clustering was implemented to group similar cycling sessions together establishing a classification of different types of training. A Wilcoxon test was performed to look for differences in effort between phases of the menstrual cycle.

### RESULTS:

Two groups of variables were distinguished in the PCA, one representing the training volume, the other the intensity. Four clusters were established: intensive effort (medium Volume, high Intensity), moderate effort (medium Volume, medium Intensity), long effort (high Volume, medium Intensity), and light effort (low Volume, low Intensity). We found a significant difference ( $p = 0.005$ ) between the Intensity of the sessions, in the cluster of intensive effort, during the menstrual phase compared to the follicular. The Intensity indicator the cyclists displayed were 2 times higher during the follicular phase in comparison with the menstruation phase. No differences across the menstrual cycle phases were found in the clusters of moderate, long or light effort ( $p > 0.05$ ).

### CONCLUSION:

The clustering of cycling sessions allows comparisons among similar training sessions. We showed greater training intensity during the follicular phase among the most intense training sessions, possibly suggesting an impact of the menstrual cycle on the most intense sessions among an elite of female athletes. These findings suggest that the hormonal phases of the menstrual cycle influence elite cyclists performance.

[1] Meignie et al., The Effects of Menstrual Cycle Phase on Elite Athlete Performance: A Critical and Systematic Review, *Frontiers in Physiology*, 2021

[2] Soumpasis et al., Real-life insights on menstrual cycles and ovulation using big data, *Human Reproduction Open* 2020

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