Timing is everything: exercise & nutrition as ‘Zeitgebers’ that influence circadian biology

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Circadian biology controls a wide variety of physiological events including metabolism in all organs. Circadian rhythms are synchronized, in part, by epigenetic ‘Zeitgebers’ (time givers) such as the light-dark cycle, the timing and consumption of food and physical activity patterns. At the molecular level, circadian clocks comprise a set of clock genes organised into a system of inter-related transcriptional feedback loops that produce daily oscillations in gene expression. These internal clocks increase the chances of survival of a species by enabling the organism to anticipate recurring changes under unpredictable environmental conditions and adapt behavioural physiological and molecular processes to the appropriate time of the day. However, entrenched in our 21st century lifestyle is the freedom and flexibility to work, eat and ‘play’ around the clock and the poor timing of these (and other) activities leads to disruptions in circadian homeostasis. These disturbances have been associated with a host of chronic metabolic disorders. In this regard, high-fat diets and unrestricted feedings patterns (consuming food over a >14 hour window during waking hours) cause metabolic perturbations that induce transcriptional reprograming within the clock that reorganize the relationships between the circadian transcriptome and the metabolome. In contrast, results from recent studies demonstrate that restricting food intake (to a window of <10 hours/day) without altering the quantity and quality of the diet can impart pleiotropic physiological benefits compared to unrestricted feeding. Thus there is potential for diet and exercise interventions to ‘rescue’ many of the deleterious effects on circadian biology induced by our modern-day lifestyle.